FINAL SUBMITTAL

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

LIMITED ENERGY STUDY

WATERVLIET ARSENAL

WATERVLIET, NEW YORK

VOLUME II

APPENDICES

CONTRACT NO. DACA65-91-C-0072

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS
NORFOLK, VIRGINIA

PREPARED BY:

ENERGY AND ENVIRONMENTAL SERVICES DEPARTMENT
REYNOLDS, SMITH AND HILLS, INC.
P.O. BOX 4850
JACKSONVILLE, FLORIDA 32201

RS&H PROJECT NO. 2900379002

AUGUST 1992

8/92

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
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Marie Wakefield,
Librarian Engineering

VOLUME II

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APPENDIX A

PRENEGOTIATION MINUTES
AND
SCOPE OF WORK

CENAO-EN-MP (415-10e) 18 December 1990

MEMORANDUM THRU Chiefs, Special Projects Sec
Military Programs Br

FOR Contract File

SUBJECT: Record of Preliminary Negotiations with Reynolds, Smith & Hills, Inc., Jacksonville, FL for A-E Services in Connection with Preparation of the Limited Energy Study (LES) for Energy Engineering Analysis Program (EEAP), Watervliet Arsenal, NY; DACA-65-91-C-0011

1. Authority to perform subject work is contained in CESAM-EN-CC memo dated 15 Aug 1990, Subject: Energy Engineering Analysis Program (EEAP), FY91 Program for Norfolk District, which authorizes an EEAP LES at Watervliet Arsenal.

2. The scope of work consists of reviewing the previously completed Energy Engineering Analysis Program (EEAP) study which applies to the specific building, system, or energy conservation opportunity (ECOS) covered by this study; performing a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOS included in this study; reevaluating the specific project or ECO from the previous study to determine its economic feasibility based on revised criteria, current site conditions, and technical applicability; evaluating specific ECOS to determine their energy savings potential and economic feasibility; providing project documentation for recommended ECOS; and preparing a comprehensive report to document all work performed, the results, and the recommendations. The scope of work and services to be performed are further described in enclosed Scope of Work for an LES at Watervliet Arsenal.

3. The project scope of work and proposed A-E services were discussed in detail at a preliminary negotiations meeting and site visit held at Watervliet Arsenalin Building 120 on 6 December 1990 at 0830 among the following:

Participant	Representing
Paul Hutchins	RSH
Bill Face	SMCWV-EHE
Frank Mercurio	SMCWV-EHE
Timpy Uppal	SMSWV-ODP-IO
Bryant Wilkins	CENAO-EN-MS

4. The following schedule for the project was agreed to, subject to timely receipt of additional Government furnished information which is essential to the performance of the A-E contract. The periods of time for A-E services are obligatory. Deviations in the schedule by the Government will in no way abrogate the time periods for the A-E:

Start effort immediately after award of of the contract such that effort will be Complete & Approved not later than 365 days after award of the contract.

5. The quantities of documents required at the various submissions are as shown in enclosed detailed scope of work.

6. The A-E was requested to expedite preparation of the proposal.

Bryant Wilkins

Enclosure

BRYANT WILKINS
Project Manager
Special Projects Section

James N. Thomasson, P.E.
Chief, Engineering Division

The preceding Record of Preliminary Negotiations adequately describes my understanding of the scope of the proposed A-E contract and the work to be performed by our firm. I am familiar with Clause (Responsibilities of the Architect-Engineer).

Jue Hutchins

Authorized Representative of
Reynolds, Smith & Hills, Inc.

PRENEGOTIATION MEETING--WATERVLIET ARSENAL LIMITED ENERGY STUDY
ADDITIONAL NOTES

- Power factor correction is desired.
- Architectural modifications are difficult on many buildings due to historical value.
- Project has been designed for heat exchanger on Building 125 exhaust system. WVA is looking at a completely new system with make-up air.
- Exhaust heat recovery is possible in Building 25.
- Reduce OSA intake in Building 44.
- Cogeneration is popular.
- Niagra Mohawk is the utility.
- Evaluating switch from No. 6 fuel oil to natural gas.
- Five boilers, 135 psia, two 50 k#/hr, two 100 k#/hr, one 25 k#/hr.
- Natural gas used in donkey boiler, Selas Furnace and some heat treat.
- Steam used for space heating in all buildings except Building 10, where it is converted to hot water.
- Largest energy users--Tocco induction furnace, rotary forge.
- Air compressors have cooling towers; others for heat treat, Selas furnace and Tocco furnace.
- Only significant space cooling is in Building 40, Benet Labs, two 750-ton chillers.
- Donkey boiler is used only for process steam in Building 35 during the summer--25 k#/hr.
- Weatherization; none except Building 22, Building 4 (second floor) and Building 10 (unit 4/5).
- Metering ~30 electric, five natural gas and a few steam.
- Condensate is not returned from chrome plating in Building 35. Could be used to preheat boiler make-up water.

CESAM-EN-CC

May 1991
Revision 2

GENERAL SCOPE OF WORK

FOR A

LIMITED ENERGY STUDY

WATERVLIET ARSENAL

WATERVLIET, NY

DACA-65-91-C-0072

Performed as part of the

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

BASIC CONTRACT - INDUSTRIAL FACILITIES AT WVAD

OPTION - ANCILLARY FACILITIES AT WVAD

SCOPE OF WORK
FOR A
LIMITED ENERGY STUDY
WATERVLIET ARSENAL

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ANNEXES

1. BRIEF DESCRIPTION OF WORK: The Architect-Engineer (AE) shall:

1.1 Review the previously completed Energy Engineering Analysis Program (EEAP) study which applies to the specific building, system, or energy conservation opportunity (ECO) covered by this study.

1.2 Perform a limited site survey of specific buildings or areas to collect all data required to evaluate the specific ECOs included in this study.

1.3 Reevaluate the specific project or ECO from the previous study to determine its economic feasibility based on revised criteria, current site conditions and technical applicability.

1.4 Evaluate specific ECOs to determine their energy savings potential and economic feasibility.

1.5 Provide project documentation for recommended ECOs as detailed herein.

1.6 Prepare a comprehensive report to document all work performed, the results and all recommendations.

2. GENERAL

2.1 This study is limited to the evaluation of the specific buildings, systems, or ECOs listed in Annex A, DETAILED SCOPE OF WORK.

2.2 The information and analysis outlined herein are considered to be minimum requirements for adequate performance of this study.

2.3 For the buildings, systems or ECOs listed in Annex A, all methods of energy conservation which are reasonable and practical shall be considered, including improvements of operational methods and procedures as well as the physical facilities. All energy conservation opportunities which produce energy or dollar savings shall be documented in this report. Any energy conservation opportunity considered infeasible shall also be documented in the report with reasons for elimination.

2.4 The study shall consider the use of all energy sources applicable to each building, system, or ECO.

2.5 The "Energy Conservation Investment Program (ECIP) Guidance", described in letter from CEHSC-FU, dated 25 April 1988 and the latest revision from CEHSC-FU establishes criteria for ECIP projects and shall be used for performing the economic analyses of all ECOs and projects. The program, Life Cycle Cost In Design (LCCID), has been developed for performing life cycle cost calculations in accordance with ECIP guidelines and is referenced

in the ECIP Guidance. If any program other than LCCID is proposed for life cycle cost analysis, it must use the mode of calculation specified in the ECIP Guidance. The output must be in the format of the ECIP LCCA summary sheet, and it must be submitted for approval to the Contracting Officer.

2.6 Computer modeling will be used to determine the energy savings of ECOs which would replace or significantly change an existing heating, ventilating, and air-conditioning (HVAC) system. The requirement to use computer modeling applies only to heated and air-conditioned or air-conditioned-only buildings which exceed 8,000 square feet or heated-only buildings in excess of 20,000 square feet. Modeling will be done using a professionally recognized and proven computer program or programs that integrate architectural features with air-conditioning, heating, lighting and other energy-producing or consuming systems. These programs will be capable of simulating the features, systems, and thermal loads of the building under study. The program will use established weather data files and may perform calculations on a true hour-by-hour basis or may condense the weather files and the number of calculations into several "typical" days per month. The Detailed Scope of Work, Annex A, will list programs that are acceptable to the Contracting Officer. If the AE desires to use a different program, it must be submitted for approval with a sample run , an explanation of all input and output data, and a summary of program methodology and energy evaluation capabilities.

2.7 Energy conservation opportunities determined to be technically and economically feasible shall be developed into projects acceptable to the installation personnel. This may involve combining similar ECOs into larger packages which will qualify for ECIP, MCA, or PCIP funding. However, preparation of programming documents such as DD Forms 1391, Project Development Brochures, or DA Forms 5108-R will not be required.

2.7.1 Projects which qualify for ECIP funding shall be identified, separately listed, and prioritized by the Savings to Investment Ratio (SIR).

2.7.2 All feasible non-ECIP projects shall be ranked in order of highest to lowest SIR.

2.7.3 At some installations Energy Conservation and Management (ECAM) funding will be used instead of ECIP funding. The criteria for each program is the same. The Director of Engineering and Housing will indicate which program is used at this installation. This Scope of Work mentions only ECIP, however, ECAM is also meant.

3. PROJECT MANAGEMENT

3.1 Project Managers. The AE shall designate a project manager to serve as a point of contact and liaison for work required under this contract. Upon award of this contract, the

individual shall be immediately designated in writing. The AE's designated project manager shall be approved by the Contracting Officer prior to commencement of work. This designated individual shall be responsible for coordination of work required under this contract. The Contracting Officer will designate a project manager to serve as the Government's point of contact and liaison for all work required under this contract. This individual will be the Government's representative.

3.2 Installation Assistance. The Commanding Officer or authorized representative at the installation will designate an individual to assist the AE in obtaining information and establishing contacts necessary to accomplish the work required under this contract. This individual will be the installation representative.

3.3 Public Disclosures. The AE shall make no public announcements or disclosures relative to information contained or developed in this contract, except as authorized by the Contracting Officer.

3.4 Meetings. Meetings will be scheduled whenever requested by the AE or the Contracting Officer for the resolution of questions or problems encountered in the performance of the work. The AE's project manager and the Government's representative shall be required to attend and participate in all meetings pertinent to the work required under this contract as directed by the Contracting Officer. These meetings, if necessary, are in addition to the presentation and review conferences.

3.5 Site Visits, Inspections, and Investigations. The AE shall visit and inspect/investigate the site of the project as necessary and required during the preparation and accomplishment of the work.

3.6 Records

3.6.1 The AE shall provide a record of all significant conferences, meetings, discussions, verbal directions, telephone conversations, etc., with Government representative(s) relative to this contract in which the AE and/or designated representative(s) thereof participated. These records shall be dated and shall identify the contract number, and modification number if applicable, participating personnel, subject discussed and conclusions reached. The AE shall forward to the Contracting Officer within ten calendar days, a reproducible copy of the records.

3.6.2 The AE shall provide a record of requests for and/or receipt of Government-furnished material, data, documents, information, etc., which if not furnished in a timely manner, would significantly impair the normal progression of the work under this contract. The records shall be dated and shall identify the contract number and modification number, if applicable. The AE shall

forward to the Contracting Officer within ten calendar days, a reproducible copy of the record of request or receipt of material.

3.7 Interviews. The AE and the Government's representative shall conduct entry and exit interviews with the Director of Engineering and Housing before starting work at the installation and after completion of the field work. The Government's representative shall schedule the interviews at least one week in advance.

3.7.1 Entry. The entry interview shall describe the intended procedures for the survey and shall be conducted prior to commencing work at the facility. As a minimum, the interview shall cover the following points:

a. Schedules.

b. Names of energy analysts who will be conducting the site survey.

c. Proposed working hours.

d. Support requirements from the Director of Engineering and Housing.

3.7.2 Exit. The exit interview shall briefly describe the items surveyed and probable areas of energy conservation. The interview shall also solicit input and advice from the Director of Engineering and Housing.

4. SERVICES AND MATERIALS. All services, materials (except those specifically enumerated to be furnished by the Government), plant, labor, supervision and travel necessary to perform the work and render the data required under this contract are included in the lump sum price of the contract.

5. PROJECT DOCUMENTATION. All energy conservation opportunities which the AE has considered shall be included in one of the following categories and presented in the report as such:

5.1 ECIP Projects. To qualify as an ECIP project, an ECO, or several ECOs which have been combined, must have a construction cost estimate greater than $200,000, a Savings to Investment Ratio greater than one and a simple payback period of less than four years. For ECAM projects, the $200,000 limitation may not apply; in such cases, the AE shall check with the installation for guidance. The overall project and each discrete part of the project shall have an SIR greater than one. All projects meeting the above criteria shall be arranged as specified in paragraph 2.7.1 and provided with the following documentation: life cycle cost analysis (LCCA) summary sheet, description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must

take into account the synergistic effects of the individual ECOs. [For projects and ECOs reevaluated from previous studies, the backup data shall consist of copies of the original calculations and analysis, with new pages revising the original calculations and analysis. In addition, the backup data shall include as much of the following as is available: the increment of work under which the project or ECO was developed in the previous study, title(s) of the project(s), the energy to cost (E/C) ratio, the benefit to cost (B/C) ratio, the current working estimate (CWE), and the payback period. The purpose of this information is to provide a means to prevent duplication of projects in any future reports.]

5.2 Non-ECIP Projects. Projects which do not meet ECIP criteria with regard to cost estimate, payback period, or nonenergy (75%) qualification test, but which have an SIR greater than one shall be documented. Projects or ECOs in this category shall be arranged as specified in paragraph 2.7.2 and provided with the following documentation: the life cycle cost analysis (LCCA) summary sheet completely filled out, a description of the work to be accomplished, backup data for the LCCA, ie, energy savings calculations and cost estimate(s), and the simple payback period. The energy savings for projects consisting of multiple ECOs must take into account the synergistic effects of the individual ECOs. In addition, these projects shall be grouped as required by the Government's representative, for one of the following categories:

a. Quick Return on Investment Program (QRIP). This program is for projects which have a total cost not over $100,000 and a simple payback period of two years or less.

b. OSD Productivity Investment Funding (OSD PIF). This program is for projects which have a total cost of more than $100,000 and a simple payback period of four years or less.

c. Productivity Enhancing Capital Investment Program (PECIP). This program is for projects which have a total cost of more than $3,000 and a simple payback period of four years or less.

The above programs are all described in detail in AR 5-4, Change No. 1.

d. Regular Military Construction Army (MCA) Program. This program is for projects which have a total cost greater than $200,000 and a simple payback period of four to twenty-five years.

e. Low Cost/No Cost Projects. These are projects which the Director of Engineering and Housing can perform using his resources.

5.3 Nonfeasible ECOs. All ECOs which the AE has considered but which are not feasible, shall be documented in the report with reasons and justifications showing why they were rejected.

6. DETAILED SCOPE OF WORK. The Detailed Scope of Work is contained in Annex A.

7. WORK TO BE ACCOMPLISHED.

7.1 Review Previous Studies. Review the previous EEAP study which applies to the specific building, system, or ECO covered by this study. This review should acquaint the AE with the work that has been performed previously. Much of the information the AE may need to develop the ECOs in this study may be contained in the previous study.

7.2 Perform a Limited Site Survey. The AE shall obtain all necessary data to evaluate the ECOs or projects by conducting a site survey. However, the AE is encouraged to use any data that may have been documented in a previous study. The AE shall document his site survey on forms developed for the survey, or standard forms, and submit these completed forms as part of the report. All test and/or measurement equipment shall be properly calibrated prior to its use.

7.3 Reevaluate Selected Projects. The AE shall reevaluate the projects and ECOs listed in Annex A. These are projects and ECOs that the previous study has identified but that have not been accomplished or only parts have been accomplished. If the project or ECO is acceptable as is, that is, there are no changes to the basic project or ECO, the energy savings shown in the previous project may be accepted as accurate but the energy cost and construction cost estimates shall be updated based on the most current data available. With the above information the project shall then be analyzed based on current ECIP criteria. If the project or ECO is basically acceptable but some of the buildings in the original project have been deleted or new buildings can be added, the necessary changes shall be made to the energy savings, the energy costs and construction costs shall be updated, and the revised project or ECO shall then be analyzed using current ECIP guidance. If the original project or ECO has had numerous changes made to it so that all of the numbers are suspected of being inaccurate, but the project or ECO is still considered feasible, the AE shall develop the project from the beginning and analyze it with the current ECIP guidance. These projects shall be separately listed in the report.

7.4 Evaluate Selected ECOs. The AE shall analyze the ECOs listed in Annex A. These ECOs shall be analyzed in detail to determine their feasibility. Savings to Investment Ratios (SIRs) shall be determined using current ECIP guidance. The AE shall provide all data and calculations needed to support the recommended ECO. All assumptions shall be clearly stated. Calculations shall be prepared showing how all numbers in the ECO were figured. Calculations shall be an orderly step-by-step progression from the first assumption to the final number. Descriptions of the products, manufacturers catalog cuts, pertinent drawings and sketches shall also be included. A life cycle cost analysis summary sheet shall

be prepared for each ECO and included as part of the supporting data.

7.5 Combine ECOs Into Recommended Projects. During the Interim Review Conference, as outlined in paragraph [7.6.1], the AE will be advised of the DEH's preferred packaging of recommended ECOs into projects for implementation. Some projects may be a combination of several ECOs, and others may contain only one. These projects will be evaluated and arranged as outlined in paragraphs 5.1, 5.2, and 5.3. Energy savings calculations shall take into account the synergistic effects of multiple ECOs within a project and the effects of one project upon another. The results of this effort will be reported in the Final Submittal per par [7.6.2].

7.6 Submittals, Presentations and Reviews. The work accomplished shall be fully documented by a comprehensive report. The report shall have a table of contents and shall be indexed. Tabs and dividers shall clearly and distinctly divide sections, subsections, and appendices. All pages shall be numbered. Names of the persons primarily responsible for the project shall be included. The AE shall give a formal presentation of the interim submittal to installation, command, and other Government personnel. Slides or view graphs showing the results of the study to date shall be used during the presentation. During the presentation, the personnel in attendance shall be given ample opportunity to ask questions and discuss any changes deemed necessary to the study. A review conference will be conducted the same day, following the presentation. Each comment presented at the review conference will be discussed and resolved or action items assigned. It is anticipated that the presentation and review conference will require approximately one working day. The presentation and review conference will be at the installation on the date agreeable to the Director of Engineering and Housing, the AE and the Government's representative. The Contracting Officer may require a resubmittal of any document(s), if such document(s) are not approved because they are determined by the Contracting Officer to be inadequate for the intended purpose.

7.6.1 Interim Submittal. An interim report shall be submitted for review after the field survey has been completed and an analysis has been performed on all of the ECOs. The report shall indicate the work which has been accomplished to date, illustrate the methods and justifications of the approaches taken and contain a plan of the work remaining to complete the study. Calculations showing energy and dollar savings, SIR, and simple payback period of all the ECOs shall be included. The results of the ECO analyses shall be summarized by lists as follows:

a. All ECOs eliminated from consideration shall be grouped into one listing with reasons for their elimination as discussed in par 5.3.

b. All ECOs which were analyzed shall be grouped into two listings, recommended and non-recommended, each arranged in order

of descending SIR. These lists may be subdivided by building or area as appropriate for the study.

The AE shall submit the Scope of Work and any modifications to the Scope of Work as an appendix to the report. A narrative summary describing the work and results to date shall be a part of this submittal. At the Interim Submittal and Review Conference, the Government's and AE's representatives shall coordinate with the Director of Engineering and Housing to provide the AE with direction for packaging or combining ECOs for programming purposes and also indicate the fiscal year for which the programming or implementation documentation shall be prepared. The survey forms completed during this audit shall be submitted with this report. The survey forms only may be submitted in final form with this submittal. They should be clearly marked at the time of submission that they are to be retained. They shall be bound in a standard three-ring binder which will allow repeated disassembly and reassembly of the material contained within.

7.6.2 Final Submittal. The AE shall prepare and submit the final report when all sections of the report are 100% complete and all comments from the interim submittal have been resolved. The AE shall submit the Scope of Work for the study and any modifications to the Scope of Work as an appendix to the submittal. The report shall contain a narrative summary of conclusions and recommendations, together with all raw and supporting data, methods used, and sources of information. The report shall integrate all aspects of the study. The recommended projects, as determined in accordance with paragraph 5, shall be presented in order of priority by SIR. The lists of ECOs specified in paragraph [7.6.1] shall also be included for continuity. The final report and all appendices shall be bound in standard three-ring binders which will allow repeated disassembly and reassembly. The final report shall be arranged to include:

a. An Executive Summary to give a brief overview of what was accomplished and the results of this study using graphs, tables and charts as much as possible (See Annex B for minimum requirements).

b. The narrative report describing the problem to be studied, the approach to be used, and the results of this study.

c. Documentation for the recommended projects (includes LCCA Summary Sheets).

d. Appendices to include as a minimum:

1) Energy cost development and backup data

2) Detailed calculations

3) Cost estimates

4) Computer printouts (where applicable)

5) Scope of Work

ANNEX A

DETAIL SCOPE OF WORK
LIMITED ENERGY STUDY
WATERVLIET ARSENAL

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BUILDINGS TO BE AUDITED AND GENERAL ECOs

BASIC INDUSTRIAL FACILITIES

Building No.	Description
35	Med. Caliber Tube Bldg.
110 (South end)	Heavy Caliber Tube Bldg.
125	Breech Comp. & Weld Shop Bldg.
135	Heavy Caliber Tube Shop

General ECOs

a. Waste heat recovery from industrial processes
b. Industrial process ventilation and exhaust systems
c. Industrial process controls
d. Energy-efficient motors and variable frequency drives

OPTION 1 - ANCILLARY FACILITIES

Number	Building Number	Description
1	10	Campbell Hall
2	15	Garage (Motor Pool)
3	20	Major Component Building
4	21	O'Keefe Hall
5	22	Fire Station
6	23	Operations Office
7	24	Operations Office
8	25	Minor Comp. Bldg. & Op. Offices
9	38	Storehouse and Museum
10	40	Benet Labs & Others
11	44	Dalliba Hall/Product Assurance
12	110	(Remainder) Heavy Caliber Tube Bldg.
13	115	Maggs Research Center
14	120	Facilities Offices and Shops
15	130	Storehouse/Processing Bldg.
16	136	Boiler Plant
17	145	Warehouse & Property Disposal

GENERAL ECOs

a. Steam distribution and condensate return systems
b. Building ventilation and exhaust systems
c. Radiant heating
d. Space heating controls
e. Energy-efficient lighting
f. Energy-efficient ballasts
g. Lighting controls (including occupancy sensors, photocells, separate switching)
h. Fluorescent fixture reflectors

SPECIFIC ECOs

- Power factor correction for electrical system
- Fuel switch from FSR to Natural Gas (Building #136)
- Congeneration
- Reduce heat loss in dip tank operation (Building #35)
- Electrical demand peak reduction
- Improve steam distribution and condensate return system.

ECOs TO BE UPDATED

- None -

SCHEDULE OF ACTIVITIES

Activity	Calendar Days (NTP Plus)
NTP	0
Interim Submittal	145
Interim Review Conference	195
Prefinal Submittal	235
Prefinal Review Conference	270
Prefinal (Corrected)/Final Submittal	305

SUBMITTAL DISTRIBUTION LIST

Address	Interim 60%	Final 100%
Commander U.S. Army Engineer Division, North Atlantic ATTN: CENAD-EN-MM 90 Church Street New York, NY 10007	2 cys	2 cys
Commander Office of Chief of Engineerg ATTN: CEEC-EE (McCarty) Pulaski Building Washington, DC 20314	Executive Summary Only 1 cy	1 cy
Commander U.S. Army Engineer District, Norfolk Attn: CENAO-EN-MP (Wilkins) 803 Front Street Norfolk, VA 23510	2 cys	2 cys
Army Energy Office ATTN: DALO-LEP (Keath) New Cumberland Army Depot New Cumberland, PA 17070	Executive Summary Only 1 cy	1 cy
Commander Watervliet Arsenal ATTN: SMCWV-FE (Bill Face) Building 120 Watervliet, NY 12189	2 cys	2 cys
Commander USAMC Installations & Services Activity ATTN: AMXEN B (G. Badtram) Building 60, 2nd Floor Rock Island, IL 61299-7190	1 cy	1 cy
	9	9

GOVERNMENT FURNISHED CRITERIA

1. Building information schedule (manual).

2. Production equipment schedule.

3. Utility procurement records (including reimburseable).

4. Facilities engineering technical data support.

5. Equipment modernization/acquisition plan.

6. Basic utility systems information maps.

7. Equipment layout and utilization records.

8. Final reports of previously completed studies performed under the Energy Engineering Analysis Program (EEAP). Only portions pertaining to the industrial facilities, if any, need to be made available.

9. Latest copies of any other energy studies performed since the previous EEAP study. Only portions pertaining to the industrial facilities, if any, need to be made available.

10. Energy Resources Management Plan.

11. ETLs 1110-3-282, Energy Conservation; 1110-3-318, Procedures for Programming Energy Monitoring and Control Systems (EMCS) Funded Through the MCA Program; 1110-3-332, Economic Studies; and 1110-3-354, Direct Digital Control of Heating, Ventilation and Air Conditioning (HVAC) Systems.

12. Architectural and engineering instructions.

13. Energy Conservation Investment Program (ECIP) Guidance, dated 25 April 1988 and revision dated 15 June 1989.

14. Information on Existing EMCS Studies, Designs, Construction Contracts, or Operating Systems.

15. TM 5-785, Engineering Weather Data; TM 5-800-2, General Criteria Preparation of Cost Estimation; TM 5-800-3, Project Development Brochure; and TM 5-815-2, Energy Monitoring and Control Systems (EMCS).

16. AR 415-15, Military Construction Army (MCA) Program Development; AR 415-17, Cost Estimating for Military Programming; AR 415-20, Construction, Project Development and Design Approval; AR 415-28, Department of the Army Facility Classes and Construction Categories; AR 415-35, Construction, Minor

Construction; AR 420-10, General Provisions, Organization, Functions and Personnel; AR 11-27, Army Energy Program; and AR 5-4, Change Number 1, Department of the Army Productivity Improvement Program.

17. HNDSP-84-076-ED-ME, Preliminary Survey and Feasibility Study for Energy Monitoring and Control Systems.

18. NCEL CR 82.030, Standardized EMCS Energy Savings Calculations. (Only if needed for this study.)

19. HNDSP88-207-ED-ME, HNDSP88-208-ED-ME, HNDSP88-209-ED-ME and HNDSP88-210-ED-ME, EMCS Cost Estimating Guides.

20. The latest applicable Engineer Improvement Recommendation System (EIRS) bulletin.

21. An example of a correctly completed programming document for an ECIP/ECAM project.

22. Production data.

23. EEAP PRC (11/84)

24. Energy Management Proposal, Niagra-Mohawk (10/90)

SPECIAL REQUIREMENTS AND INFORMATION

1. Point of contact at Watervliet Arsenal and liaison for all work required under this contract is:

Bill Face
Watervliet Arsenal
ATTN: SMCWV-FE
Building 120
Watervliet, NY
Phone: (518) 266-4225

2. The fiscal year to which all ECIP projects should be estimated to and programming or implementation documents prepared for is FY TBD. Depending on project packaging, the Installation Commander may determine different program years for the final report. Remaining projects shall be escalated to a FY TBD.

3. A computer program titled Life Cycle Costing in Design (LCCID) is available from the BLAST Support Office in Urbana, Illinois for a nominal fee. The computer program can be used for performing the economic calculations for ECIP and non-ECIP ECOs. The AE is encouraged to obtain this computer program. The BLAST Support Office can be contacted at 144 Mechanical Engineering Building, 1206 West Green Street, Urbana, Illinois 61801. The telephone number is (217) 333-3977. AE shall indicate in writing what program will be used.

4. Consolidated review comments will be provided to AE by Project Manager about 14 days prior to review conferences. AE will review each comment and provide consolidated proposed responses to Project Manager 48 hours prior to conference.

5. AE will provide cover letter with all submittals noting a review is required and that a Review Conference is scheduled approximately 45 days hence. Letter will also inform recipients of letter to follow from Norfolk District COE setting exact conference date.

6. Acceptable programs for computer modeling of building energy systems are:

a. BLAST*

b. DOE 2.1B*

c. Carrier E20 or HAP**

d. TRACE**

*Very accurate, but requires a lot of time for input; therefore, rather expensive for straightforward projects.

**Adequate for load determination, equipment selection, and energy performance for most projects.

ANNEX B

EXECUTIVE SUMMARY GUIDELINE

1. Introduction.

2. Building Data (types, number of similar buildings, sizes, etc.)

3. Present Energy Consumption of Buildings or Systems Studied.

   - Total Annual Energy Used.

   - Source Energy Consumption.

     Electricity - KWH, Dollars, BTU
     Fuel Oil - GALS, Dollars, BTU
     Natural Gas - THERMS, Dollars, BTU
     Propane - GALS, Dollars, BTU
     Other - QTY, Dollars, BTU

4. Reevaluated Projects Results.

5. Energy Conservation Analysis.

   - ECOs Investigated.

   - ECOs Recommended.

   - ECOs Rejected. (Provide economics or reasons)

   - ECIP Projects Developed. (Provide list)*

   - Non-ECIP Projects Developed. (Provide list)*

   - Operational or Policy Change Recommendations.

* Include the following data from the life cycle cost analysis summary sheet: the cost (construction plus SIOH), the annual energy savings (type and amount), the annual dollar savings, the SIR, the simple payback period and the analysis date.

6. Energy and Cost Savings.

   - Total Potential Energy and Cost Savings.

   - Percentage of Energy Conserved.

   - Energy Use and Cost Before and After the Energy Conservation Opportunities are Implemented.

APPENDIX B

BACKUP DATA AND CALCULATIONS

APPENDIX B

BACKUP DATA, CALCULATIONS AND COST ESTIMATES

TABLE OF CONTENTS

ENERGY PRICES, DATA, BASIC ASSUMPTIONS, ECONOMIC PARAMETERS

WATERVLIET ARSENAL

ENERGY PRICES AND ECONOMIC PARAMETERS

ENERGY PRICES:

Electricity: 3,413 Btu/kwh, $0.06945/kwh or $20.35/MBtu (average)

Customer Charge: $305.17 per month

On-Peak Energy Charge: $0.0605/kwh, $17.73/MBtu
(0800-2200 hrs M-F)

Off-Peak Energy Charge: $0.045 kwh, $13.18/MBtu

Demand Charge: $5.77/kw/month (on-peak)

Power Factor Charge: $0.873/kva of lagging reactive demand (KVAR)

Source: Niagara Mohawk Electric Bill (July 1991)

Natural Gas: 100,000 Btu/therm,

Firm: $0.416/therm or $4.16/MBtu (average)

Spot and Transportation = $2.99 + $0.44 = $3.43/MBtu

Source: Watervliet Arsenal Engineering

Fuel Oil No. 2: 138,690 Btu/gallon, $0.69/gallon, $5.00/MBtu

Source: Watervliet Arsenal Engineering (FY 92 rates)

Fuel Oil No. 6: 149,690 Btu/gallon, $0.66/gallon, $4.40/MBtu

Source: Watervliet Arsenal Engineering (FY 92 rates)

BASIS FOR COST ESTIMATES:

Adjustment	Labor	Material	Comments
Sales Tax	N.A.	N.A.	WVA is tax exempt
FICA/Insurance	20.0%	N.A.	
Overhead	15.0%		
Profit	10.0%		
Performance Bond	1.0%		
Contingency	10.0%		
SIOH	6.0%		Input by LCCID Program
Design Fees	6.0%		Input by LCCID Program

ADDS REPORT: PROD - AEO MACOMDB REPORT
RUN ON : 06/28/91 08:56:18
FOR : W16H1F WATERVLIET ARSENAL

UTILITIES CONSUMPTION -- TOTAL FACILITY

PRODUCT/PRODUCT GROUP

	FY90 COST ($000)	FY85 CONSUMPTION (MBTUS)	FY88 CONSUMPTION (MBTUS)	FY89 CONSUMPTION (MBTUS)	FY90 CONSUMPTION (MBTUS)	90 VS 85 PER CENT CHANGE	$/MBTU
UTILITY							
ELC							
	3,300	167,869	176,704	171,257	172,574	-2.80	19.12
NAG							
	310	58,318	84,136	200,697	65,675	-12.fb	4.72
* SUBTOTAL *							
	3,610	226,187	260,840	371,954	238,249	-5.33	15.15
PETROLEUM							
FSD							
	50	6,570	8,079	7,613	12,320	-87.52	4.04
FSR							
	983	318,306	301,751	275,371	277,616	12.78	3.54
* SUBTOTAL *							
	1,033	324,876	309,830	282,984	289,936	10.75	3.56
* * TOTAL * *							
	4,643	551,063	570,670	654,938	528,185	4.15	8.79

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
INCLUDES : FROM OCT89 THRU SEP90
RUN ON : 06/28/91 08:48:24
FOR : W16H1F WATERVLIET ARSENAL
UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
ELC	90	OCT 89	13642	0	201	0	13843
		NOV 89	14365	0	253	0	14618
		DEC 89	13823	0	235	0	14058
		JAN 90	14212	0	270	0	14482
		FEB 90	13495	0	246	0	13741
		MAR 90	15341	0	239	0	15580
		APR 90	13928	0	218	0	14146
		MAY 90	13867	0	225	0	14092
		JUN 90	15058	0	218	0	15276
		JUL 90	14273	0	215	0	14488
		AUG 90	12700	0	229	0	12929
		SEP 90	15099	0	222	0	15321
	*		169803	0	2771	0	172574

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
INCLUDES : FROM SEP89 THRU SEP90
RUN ON : 06/28/91 08:51:12
FOR : W16H1F WATERVLIET ARSENAL
UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
NAG	90	OCT 89	5477	0	0	0	5477
		NOV 89	4262	0	5	0	4267
		DEC 89	5645	0	5	0	5650
		JAN 90	6183	0	22	0	6205
		FEB 90	4037	0	22	0	4059
		MAR 90	5175	0	14	0	5189
		APR 90	5508	0	14	0	5522
		MAY 90	9006	0	13	0	9019
		JUN 90	8117	0	0	0	8117
		JUL 90	4024	0	3	0	4027
		AUG 90	3196	0	0	0	3196
		SEP 90	4945	0	2	0	4947
	*		65575	0	100	0	65675

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
INCLUDES : FROM OCT89 THRU SEP90
RUN ON : 06/28/91 08:52:40
FOR : W16H1F WATERVLIET ARSENAL
UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
FSR	90	OCT 89	22262	0	692	0	22954
		NOV 89	38558	0	1088	0	39646
		DEC 89	54024	0	1855	0	55879
		JAN 90	42066	0	2207	0	44273
		FEB 90	52830	0	1685	0	54515
		MAR 90	36012	0	0	0	36012
		APR 90	14209	0	666	0	14875
		MAY 90	9462	0	0	0	9462
	*		269423	0	8193	0	277616

ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
INCLUDES : FROM OCT89 THRU SEP90
RUN ON : 06/28/91 08:53:41
FOR : W16H1F WATERVLIET ARSENAL
UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
FSD	90	OCT 89	70	0	367	0	437
		NOV 89	635	0	0	0	635
		DEC 89	431	0	0	0	431
		JAN 90	2149	0	0	0	2149
		FEB 90	967	0	0	0	967
		MAR 90	239	0	0	0	239
		APR 90	3926	0	0	0	3926
		MAY 90	2674	0	0	0	2674
		JUN 90	47	0	0	0	47
		JUL 90	58	0	0	0	58
		AUG 90	87	0	414	0	501
		SEP 90	256	0	0	0	256
	*		11539	0	781	0	12320

PAGE 1
ADDS REPORT: PROD - AEO MACOMDB REPORT
RUN ON : 02/06/92 10:31:53
FOR : W16H1F WATERVLIET ARSENAL

UTILITIES CONSUMPTION -- TOTAL FACILITY

PRODUCT/PRODUCT GROUP

	FY91 COST ($000)	FY85 CONSUMPTION (MBTUS)	FY89 CONSUMPTION (MBTUS)	FY90 CONSUMPTION (MBTUS)	FY91 CONSUMPTION (MBTUS)	91 VS 85 PER CENT CHANGE	$/MBTU
UTILITY							
ELC	3,671	167,869	171,257	172,574	~~104,997~~ 182,203	~~37.45~~ 8.54	~~34.96~~ 20.15
NAG	355	58,318	~~200,697~~ 87,410	65,675	~~69,731~~ 84,527	~~-19.57~~ 44.94	5.10
* SUBTOTAL *	4,026	226,187	~~371,954~~ 258,667	238,249	~~174,728~~ 266,730	~~22.75~~ 17.92	23.04
PETROLEUM							
FSD	58	6,570	~~7,613~~ 6743	~~12,320~~ 7393	~~7,853~~ 2002	~~-19.53~~ -69.53	7.43
FSR	1,939	318,306	275,371	~~277,616~~ 286,335	~~293,237~~ 302,279	~~7.88~~ -5.04	6.61
FSX	0	N/A	N/A	N/A	~~500~~ 0	N/A	0.00
* SUBTOTAL *	1,998	324,876	~~282,984~~ 282,114	~~289,936~~ 293,728	~~301,590~~ 304,281	~~7.17~~ -6.34	6.62
* * TOTAL * *	6,024	551,063	~~654,938~~ 540,781	~~528,185~~ 531,977	~~476,318~~ 571,011	~~13.56~~ 3.62	12.65

* Obvious errors in DEIS data were corrected for FY89, 90 & 91 using information supplied by WVA engineering.

PAGE 1
ADDS REPORT: PROQUE - .DEIS-II PRODUCT QUERY
INCLUDES : FROM OCT90 THRU SEP91
RUN ON : 02/06/92 10:36:24
FOR : W16H1F WATERVLIET ARSENAL
UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED	
ELC	91	OCT 90	15096	0	198	0	~~15294~~	14,163
		NOV 90	15782	0	253	0	~~16035~~	15,893
		DEC 90	14604	0	249	0	~~14853~~	14,727
		JAN 91	14492	0	242	0	~~14734~~	14,628
		FEB 91	5976	0	253	0	~~6229~~	16,178
		MAR 91	5341	0	253	0	~~5594~~	15,450
		APR 91	6655	0	259	0	~~6914~~	14,359
		MAY 91	6498	0	232	0	~~6730~~	14,129
		JUN 91	6935	0	205	0	~~7140~~	16,184
		JUL 91	4031	0	229	0	~~4260~~	16,107
		AUG 91	2904	0	184	0	~~3088~~	14,671
		SEP 91	3887	0	239	0	~~4126~~	14,688
	*		102201	0	2796	0	104997	181,177
FSD	91	OCT 90	76	0	553	0	629	
		NOV 90	64	0	0	0	64	
		DEC 90	431	0	1549	0	1980	
		JAN 91	361	0	548	0	909	
		FEB 91	501	0	845	0	1346	
		MAR 91	408	0	431	0	839	
		APR 91	285	0	670	0	955	
		MAY 91	204	0	705	0	909	
		JUN 91	82	0	0	0	82	
		JUL 91	47	0	0	0	47	
		SEP 91	93	0	0	0	93	
	*		2552	0	5301	0	7853	
FSR	91	OCT 90	15032	0	654	0	15686	
		NOV 90	33604	0	1320	0	34924	
		DEC 90	55074	0	1798	0	56872	
		JAN 91	46216	0	2075	0	~~48291~~	57,300
		FEB 91	49466	0	1855	0	51321	
		MAR 91	40275	0	1364	0	41639	
		APR 91	33931	0	754	0	34685	
		MAY 91	6375	0	704	0	7079	
		JUN 91	1930	0	0	0	1930	
		AUG 91	163	0	0	0	163	
		SEP 91	648	0	0	0	648	
	*		282714	0	10524	0	~~293238~~	302,247
FSX	91	JAN 91	128	0	0	0	128	
		FEB 91	124	0	0	0	124	
		MAR 91	112	0	0	0	112	
		APR 91	136	0	0	0	136	

PAGE 2
ADDS REPORT: PROQUE - DEIS-II PRODUCT QUERY
INCLUDES : FROM OCT90 THRU SEP91
RUN ON : 02/06/92 10:37:13
FOR : W16H1F WATERVLIET ARSENAL
UNITS ARE : MBTUS

PROD CODE	FY	MONTH	BUILDING CONSUMED	PROCESS CONSUMED	F. HOUSING CONSUMED	MSE CONSUMED	TOTAL CONSUMED
	*		500	0	0	0	500
NAG	91	OCT 90	~~9549~~ 9600	0	0	0	9549
		NOV 90	~~4895~~ 4900	0	11	0	4906
		DEC 90	~~4751~~ 4700	0	0	0	4751
		JAN 91	~~4211~~ 4000	0	32	0	4243
		FEB 91	~~5529~~ 5300	0	0	0	5529
		MAR 91	~~5579~~ 6100	0	0	0	5579
		APR 91	~~6186~~ 5000	0	0	0	6186
		MAY 91	~~6289~~ 6800	0	12	0	6301
		JUN 91	~~6186~~ 10,900	0	0	0	6186
		JUL 91	~~5155~~ 9300	0	2	0	5157
		AUG 91	~~6186~~ 7200	0	0	0	6186
		SEP 91	~~5155~~ 10,700	0	2	0	5157
	*		69671 84,500	0	59	0	69730

Note: Obvious errors in DEIS data were corrected for FY 89, 90 & 91 using information supplied by WVA engineering.

WEATHER DATA

I-5

STATE / Station	Lat (° ′)	Long (° ′)	Elev (feet)	Winter Dry Bulb 99% (°F)	Winter Dry Bulb 97.5% (°F)	Pvlg Wind (dir)	Mean Speed (knots)	Degree Days Heating (annual)
NEW YORK (CONT)	N	W						
Niagara Falls IAP	43 06	78 57	590	4	7	W	9	6688
Ogdensburg	44 41	75 28	297	-13	-8	W	8	7777
Oswego	43 28	76 33	300	1	7	E	7	6792
Plattsburg AFB	44 39	73 28	235	-13	-8	NW	6	8044
Poughkeepsie/Dutchess Co	41 38	73 53	165	0	6	NNE	6	5824
Rochester/Monroe Co Aprt	43 07	77 40	547	1	5	WSW	11	6719
Roslyn	40 47	73 36	100	12	15	NNW	13	5084
Saint Albans NAVHOSP	40 41	73 46	50	12	15	WNW	14	5184
Saratoga AFS	43 01	73 41	617	-12	-6	WNW	8	7180
Schenectady	42 51	73 56	378	-4	1	WNW	8	6817
Seneca Army Depot	42 45	76 50	750	0	5	NW	11	6359
Suffolk Co/Westhampton Bch	40 51	72 38	67	7	10	NW	9	5951
Syracuse/Hancock IAP	43 07	76 07	410	-3	2	N	7	6772
Troy	42 46	73 39	330	-6	-1	WNW	8	6888
Utica/Oneida Co Aprt	43 09	75 23	742	-12	-6	NW	12	7299
Watertown IAP	43 59	76 01	325	-11	-6	E	7	7376
Watervliet Arsenal	42 43	73 42	35	1	5	WNW	8	6393
Westchester Co/White Plains	41 04	73 43	439	5	9	NW	9	5802
West Point USMA	41 23	73 57	160	2	6	NNE	6	5753
Whitestone	40 47	73 50	10	11	15	WNW	15	4909
Yonkers	40 56	73 53	50	11	15	WNW	15	5109
Youngstown	43 14	79 02	300	4	7	W	9	6688
NORTH CAROLINA	N	W						
Asheville MAP	35 26	82 32	2140	10	14	NNW	12	4237
Badin ANG	35 22	80 08	455	18	22	NNW	6	3218
Camp Lejeune MCS	34 40	77 21	25	20	23	NNW	7	2901
Cape Hatteras	35 16	75 33	7	25	27	NNW	11	2731
Charlotte/Douglas MAP	35 13	80 56	736	18	22	NNW	6	3218
Cherry Point MCAS	34 54	76 53	29	20	24	N	8	2832
Dare County	35 45	76 10	15	19	22	NW	8	3207
Edenton Recovery Site	36 02	76 34	19	19	22	NW	8	3082
Elizabeth City CGAS/MAP	36 16	76 11	12	19	22	NW	8	3207
Fort Bragg/Simmons AAF	35 08	78 56	242	18	21	N	7	3105

STATE / Station	Summer Dry Bulb 1% (°F)	MCWB (°F)	2.5% (°F)	MCWB (°F)	Mean Daily Range (°F)	Pvlg Wind (dir)	5% (°F)	MCWB (°F)	Wet Bulb 1% (°F)	2.5% (°F)	5% (°F)	Criteria Dry Bulb ≥ 93°F (hrs)	≥ 80°F (hrs)	Criteria Wet Bulb ≥ 73°F (hrs)	≥ 67°F (hrs)
NEW YORK (CONT)															
Niagara Falls IAP	89	74	86	72	23	SW	84	71	76	74	73	4	350	162	814
Ogdensburg	88	73	85	71	25	SW	83	69	75	73	71	2	266	89	550
Oswego	86	73	83	71	20	WSW	80	70	75	73	72	1	141	100	665
Plattsburg AFB	86	70	83	69	22	SE	80	68	73	72	70	3	171	43	432
Poughkeepsie/Dutchess Co	92	74	89	74	27	SSW	86	72	77	75	74	26	490	249	1035
Rochester/Monroe Co Aprt	91	73	88	71	26	WSW	85	70	75	73	72	15	414	112	738
Roslyn	91	74	88	73	19	SSW	85	72	77	76	74	21	476	331	1284
Saint Albans NAVHOSP	90	73	87	72	17	SSW	84	71	76	75	74	8	383	275	1222
Saratoga AFS	91	72	89	71	25	S	86	69	74	73	71	18	470	88	662
Schenectady	90	73	87	72	25	S	84	70	75	74	72	12	368	132	775
Seneca Army Depot	92	73	88	71	24	SSW	85	70	75	73	72	20	463	107	745
Suffolk Co/Westhampton Bch	86	72	83	71	18	SW	80	70	76	74	73	2	174	172	991
Syracuse/Hancock IAP	90	73	87	71	24	WNW	84	70	75	73	72	8	412	107	745
Troy	91	73	88	72	25	S	85	70	75	74	72	16	417	132	775
Utica/Oneida Co Aprt	88	73	85	71	22	W	82	70	75	73	71	7	251	87	604
Watertown IAP	86	73	83	71	20	WSW	81	70	75	73	72	1	222	100	665
Watervliet Arsenal	91	73	88	72	25	S	84	70	75	74	72	17	387	132	775
Westchester Co/White Plains	90	75	87	73	23	W	84	73	77	75	74	13	376	265	1092
West Point USMA	93	74	90	74	27	SSW	87	72	77	75	74	41	578	249	1035
Whitestone	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
Yonkers	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
Youngstown	89	74	86	72	23	SW	84	71	76	74	73	4	350	162	814
NORTH CAROLINA															
Asheville MAP	89	73	87	72	27	NNW	85	71	75	74	72	6	536	139	1143
Badin ANG	95	74	93	74	23	SW	91	74	77	76	76	87	1116	699	2288
Camp Lejeune MCS	93	80	90	79	18	S	88	77	81	80	79	30	1020	1481	2870
Cape Hatteras	87	78	86	77	12	SSW	85	77	80	79	78	0	832	1521	2771
Charlotte/Douglas MAP	95	74	93	74	23	SW	91	74	77	76	76	87	1116	699	2288
Cherry Point MCAS	92	78	90	78	17	SSW	88	77	80	79	78	23	1055	1342	2760
Dare County	93	78	91	77	19	SW	89	76	80	78	78	30	957	1158	2461
Edenton Recovery Site	93	78	91	77	19	SW	89	76	80	78	78	30	957	1158	2461
Elizabeth City CGAS/MAP	93	78	91	77	19	SW	89	76	80	78	78	30	957	1158	2461
Fort Bragg/Simmons AAF	94	76	92	76	21	WSW	89	75	78	77	76	60	1080	846	2376

STATE / Station	Location: Lat °	Lat ′	Long °	Long ′	Elev (feet)	Winter Design Data, Heating, Dry Bulb: 99% (°F)	97.5% (°F)	Pvlg Wind (dir)	Mean Speed (knots)	Degree Days: Heating (annual)	Summer Design Data, Air Conditioning, Dry Bulb: 1% (°F)	MCWB (°F)	2.5% (°F)	MCWB (°F)	Mean Daily Range (°F)	Pvlg Wind (dir)	5% (°F)	MCWB (°F)	Wet Bulb: 1% (°F)	2.5% (°F)	5% (°F)	Summer Criteria Data, Air Conditioning, Dry Bulb: ≥ 93°F (hrs)	≥ 80°F (hrs)	Wet Bulb: ≥ 73°F (hrs)	≥ 67°F (hrs)
NEW MEXICO (CONT)	N		W																						
Sacramento Peak	32	47	105	49	9240	-1	3	NW	15	7968	81	54	79	54	21	SW	76	54	59	58	57	0	59	0	0
Truth or Consequences	33	14	107	16	4858	14	18	NNW	8	3392	97	63	95	62	28	S	93	62	67	66	66	185	1374	0	65
Tucumcari	35	11	103	36	4039	8	13	NE	8	4047	99	66	97	66	30	SW	95	65	70	69	68	248	1232	1	418
Walker AFB/Roswell	33	18	104	32	3676	13	18	N	6	3697	100	66	98	66	29	SSE	96	66	71	70	69	350	1560	5	583
White Sands Missile Range	32	23	106	29	4330	21	25	SE	5	2526	99	64	97	64	24	SE	95	64	69	68	67	278	1781	10	198
Wingate Army Depot	35	31	108	35	6680	-1	4	ENE	10	5915	89	59	88	58	34	WSW	85	57	64	62	61	4	512	0	1
Zuni	35	06	108	47	6440	0	5	ENE	11	5815	90	59	89	58	34	WSW	86	58	64	62	61	8	616	0	1
NEW YORK	N		W																						
Albany	42	45	73	48	275	-6	-1	WNW	8	6888	91	73	88	72	25	S	85	70	75	74	72	16	417	132	775
Army Procurement Center	40	45	74	00	40	11	15	WNW	15	4909	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
Binghampton/Broome Co Aprt	42	13	75	59	1590	-2	1	WSW	10	7285	86	71	83	69	21	WSW	81	68	73	72	70	2	205	41	518
Brooklyn Navy Shipyard	40	42	73	58	15	11	15	WNW	15	4909	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
Buffalo IAP	42	56	78	44	705	2	6	W	10	6927	88	71	85	70	21	SW	83	69	74	73	72	2	346	92	731
Camp Drum	44	02	75	46	655	-14	-7	NW	5	7601	86	71	83	70	26	W	80	69	75	73	71	2	168	77	552
Dunkirk MAP	42	29	79	16	692	4	9	SSW	10	6851	88	73	85	72	20	WSW	83	71	75	74	72	2	317	141	814
Fort Hamilton	40	36	74	02	21	12	15	WNW	14	5184	90	73	87	72	17	SSW	84	71	76	75	74	8	383	275	1222
Fort Tilden	40	34	73	54	10	12	15	WNW	14	5184	90	73	87	72	17	SSW	84	71	76	75	74	8	383	275	1222
Fort Totten	40	48	73	47	35	11	15	WNW	15	4812	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
Fort Wadsworth	40	36	74	03	135	12	15	WNW	14	5184	90	73	87	72	17	SSW	84	71	76	75	74	8	383	275	1222
Freeport	40	38	73	35	15	12	15	WNW	14	5184	90	73	87	72	17	SSW	84	71	76	75	74	8	383	275	1222
Glen Falls/Warren Co Aprt	43	20	73	37	328	-11	-5	NNW	6	7270	88	72	85	71	25	S	82	69	74	73	71	6	277	80	591
Griffiss AFB/Rome	43	14	75	25	514	-11	-5	NW	5	7331	88	71	85	70	26	W	83	69	75	73	71	3	306	84	611
Huntington	40	52	73	24	100	12	15	NNW	13	5084	91	74	88	73	19	SSW	85	72	77	76	74	21	476	331	1284
Ithaca/Tompkins Co Aprt	42	29	76	28	1099	-5	0	W	6	7052	88	71	85	71	31	SW	82	70	74	73	71	5	252	73	625
Jamestown/Chautauqua Co	42	09	79	15	1723	-1	3	WSW	9	6849	88	70	86	70	29	WSW	83	69	74	72	71	1	305	50	627
Liverpool	43	07	76	13	400	-3	2	N	7	6678	90	73	87	71	24	WNW	84	70	75	73	72	8	412	107	745
Lockport AFS	43	08	78	50	638	4	7	W	9	6724	89	74	86	72	23	SW	84	71	76	74	73	4	350	162	814
Montauk AFS	41	04	71	52	110	12	16	NW	9	5771	82	70	79	70	14	SW	77	69	74	73	72	0	52	93	873
New Rochelle	40	50	73	47	70	11	15	WNW	15	5161	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
New York/JFK IAP	40	39	73	47	13	12	15	WNW	14	5184	90	73	87	72	17	SSW	84	71	76	75	74	8	383	275	1222
New York/La Guardia Aprt	40	46	73	54	11	11	15	WNW	15	4909	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
New York NB	40	45	74	00	40	11	15	WNW	15	4909	92	74	89	73	18	SW	87	72	76	75	74	25	602	309	1243
Newburgh/Stewart Aprt	41	30	74	06	471	-1	4	W	10	6336	90	73	88	72	23	W	85	70	76	74	73	14	460	175	886

ALBANY NEW YORK

Temperature Range	NOVEMBER Obsn Hour Gp 01 to 08	NOVEMBER Obsn Hour Gp 09 to 16	NOVEMBER Obsn Hour Gp 17 to 24	NOVEMBER Total Obsn	NOVEMBER MCWB	DECEMBER Obsn Hour Gp 01 to 08	DECEMBER Obsn Hour Gp 09 to 16	DECEMBER Obsn Hour Gp 17 to 24	DECEMBER Total Obsn	DECEMBER MCWB	JANUARY Obsn Hour Gp 01 to 08	JANUARY Obsn Hour Gp 09 to 16	JANUARY Obsn Hour Gp 17 to 24	JANUARY Total Obsn	JANUARY MCWB
95/99															
90/94															
85/89															
80/84		0		0	64										
75/79		0		0	65										
70/74		0		0	64										
65/69	1	3	1	5	59										
60/64	2	11	4	17	56	0	0	0	0	57	0	0	0	0	56
55/59	7	18	13	38	52	2	3	2	7	54	1	1	0	2	54
50/54	17	34	23	74	48	3	5	5	13	48	1	2	1	4	49
45/49	26	42	32	100	43	5	11	7	23	43	2	3	3	8	45
40/44	38	46	43	127	38	10	20	12	42	38	8	15	8	31	39
35/39	40	43	45	128	34	27	43	33	103	34	21	33	29	83	34
30/34	45	28	43	116	30	45	51	50	146	30	34	43	38	115	30
25/29	35	11	25	71	25	41	39	46	126	25	33	43	39	115	25
20/24	20	2	8	30	21	35	32	32	99	20	31	37	38	106	20
15/19	6	1	3	10	17	28	22	23	73	16	32	30	35	97	16
10/14	2	0	1	3	12	21	10	19	50	11	29	19	25	73	11
5/9	1			1	8	15	6	9	30	7	22	13	16	51	6
0/4						8	4	5	17	2	18	7	10	35	2
-5/-1						5	1	2	8	-3	10	1	3	14	-3
-10/-6						2	0	1	3	-8	3	0	2	5	-8
-15/-11						1		0	1	-12	2	0	0	2	-13
-20/-16						1			1	-17	1			1	-17
-25/-21											0			0	-23

Temperature Range	FEBRUARY Obsn Hour Gp 01 to 08	FEBRUARY Obsn Hour Gp 09 to 16	FEBRUARY Obsn Hour Gp 17 to 24	FEBRUARY Total Obsn	FEBRUARY MCWB	MARCH Obsn Hour Gp 01 to 08	MARCH Obsn Hour Gp 09 to 16	MARCH Obsn Hour Gp 17 to 24	MARCH Total Obsn	MARCH MCWB	APRIL Obsn Hour Gp 01 to 08	APRIL Obsn Hour Gp 09 to 16	APRIL Obsn Hour Gp 17 to 24	APRIL Total Obsn	APRIL MCWB
95/99															
90/94												0		0	63
85/89												1	0	1	65
80/84												2	1	3	63
75/79							0	0	0	57		5	2	7	60
70/74							1	0	1	55	0	11	5	16	57
65/69							1	1	2	54	2	18	11	31	55
60/64		0		0	56		3	1	4	51	5	25	16	46	51
55/59		1		1	50	1	6	3	10	49	11	32	25	68	49
50/54	1	3	2	6	47	3	12	8	23	45	24	42	36	102	45
45/49	1	7	4	12	42	5	27	15	47	41	37	42	43	122	42
40/44	6	18	11	35	38	14	45	31	90	37	52	39	45	136	38
35/39	21	42	32	95	34	36	55	54	145	33	55	18	36	109	34
30/34	36	46	46	128	30	67	46	59	172	30	33	5	16	54	30
25/29	35	36	39	110	25	47	27	38	112	25	15	0	3	18	25
20/24	34	26	30	90	20	37	14	22	73	20	4	1	0	5	20
15/19	24	19	24	67	15	18	7	10	35	15	2	0	1	3	16
10/14	21	12	16	49	11	11	2	4	17	11					
5/9	17	7	11	35	6	5	1	2	8	6					
0/4	8	5	6	19	1	3	0	1	4	2					
-5/-1	11	1	4	16	-3	1	0	0	1	-4					
-10/-6	5	0	1	6	-8	0		0	0	-8					
-15/-11	2	0		2	-13	0			0	-14					
-20/-16	1			1	-17	0			0	-17					
-25/-21															

Temperature Range	ANNUAL TOTAL Obsn Hour Gp 01 to 08	ANNUAL TOTAL Obsn Hour Gp 09 to 16	ANNUAL TOTAL Obsn Hour Gp 17 to 24	ANNUAL TOTAL Total Obsn	ANNUAL TOTAL MCWB
95/99		7	0	7	75
90/94		28	6	34	73
85/89	0	95	28	123	71
80/84	4	177	73	254	68
75/79	27	248	140	415	66
70/74	115	257	222	594	64
65/69	234	235	271	740	61
60/64	263	212	252	727	57
55/59	274	190	236	700	52
50/54	263	183	214	660	48
45/49	242	183	205	630	43
40/44	229	202	205	636	38
35/39	261	241	251	753	34
30/34	295	220	262	777	30
25/29	216	156	191	563	25
20/24	163	112	130	405	20
15/19	110	79	96	285	16
10/14	84	43	65	192	11
5/9	60	27	38	125	6
0/4	37	16	22	75	2
-5/-1	27	3	9	39	-3
-10/-6	10	0	4	14	-8
-15/-11	5	0	0	5	-13
-20/-16	3			3	-17
-25/-21	0			0	-23

I-6

ALBANY NEW YORK

LAT 42 45N LONG 73 48W ELEV 275 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Tempera-ture Range	MAY Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	M C W B	JUNE Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	M C W B	JULY Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	M C W B	AUGUST Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	M C W B	SEPTEMBER Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	M C W B	OCTOBER Obsn Hour Gp 01 to 08	09 to 16	17 to 24	Total Obsn	M C W B
95/99							1	0	1	76		4	0	4	74		1	0	1	75		1	0	1	76					
90/94		1	0	1	70		6	1	7	73		14	4	18	73		6	1	7	73		1	0	1	76					
85/89		4	1	5	67	0	23	8	31	70		37	12	49	71		21	5	26	71		9	2	11	73		0	0	0	62
80/84		13	5	18	65	1	39	17	57	68	2	55	27	84	68	1	48	18	67	69	0	18	5	23	71		2	0	2	67
75/79	1	25	10	36	63	6	49	31	86	65	12	64	44	120	67	6	64	38	108	66	2	30	14	46	67		11	1	12	64
70/74	3	35	21	59	60	23	45	42	110	63	44	47	62	153	65	29	60	57	146	65	15	40	28	83	64	1	18	7	26	62
65/69	12	45	37	94	57	49	39	52	140	61	80	21	59	160	63	62	32	63	157	63	24	48	34	106	60	4	28	13	45	58
60/64	29	42	42	113	54	56	24	45	125	57	58	4	28	90	59	65	12	42	119	59	37	47	47	131	57	11	44	27	82	55
55/59	44	38	46	128	51	53	12	30	95	53	32	1	10	43	55	47	3	18	68	55	46	28	46	120	53	30	47	43	120	52
50/54	52	26	37	115	47	36	3	12	51	49	16		2	18	51	27		6	33	51	45	13	34	92	49	38	43	48	129	47
45/49	52	14	32	98	43	12		2	14	45	3			3	46	11		0	11	47	38	4	20	62	45	50	33	47	130	44
40/44	34	5	14	53	39	4		0	4	41	0			0	41	1			1	43	19	0	7	26	41	43	14	34	91	39
35/39	14	0	3	17	35	1			1	37											10		2	12	36	36	7	17	60	35
30/34	7		0	7	31																4		0	4	32	24	1	10	35	31
25/29	1			1	28																0			0	28	9		1	10	27
20/24																										2			2	22

OUTSIDE AIR HEATING REQUIREMENTS

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 8

Room or Supply Air Conditions - Winter	68
Air Quantity (cfm)	1
Hour Fractions 1 AM - 9 AM	0.25
9 AM - 5 PM	0.75
5 PM - 1 AM	0
Operation Days Per Week	5

Temp.	Range	Hours of Occurrence 2-9	10-17	18-1	Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
70	74	115	257	222	222	-4	1.08	1	0	0
65	69	234	235	271	235	1	1.08	1	1	254
60	64	263	212	252	225	6	1.08	1	6	1,456
55	59	274	190	236	211	11	1.08	1	12	2,507
50	54	263	183	214	203	16	1.08	1	17	3,508
45	49	242	183	205	198	21	1.08	1	23	4,485
40	44	229	202	205	209	26	1.08	1	28	5,862
35	39	261	241	251	246	31	1.08	1	33	8,236
30	34	295	220	262	239	36	1.08	1	39	9,283
25	29	216	156	191	171	41	1.08	1	44	7,572
20	24	163	112	130	125	46	1.08	1	50	6,198
15	19	110	79	96	87	51	1.08	1	55	4,776
10	14	84	43	65	53	56	1.08	1	60	3,221
5	9	60	27	38	35	61	1.08	1	66	2,322
0	4	37	16	22	21	66	1.08	1	71	1,515
-5	-1	27	3	9	9	71	1.08	1	77	690
-10	-6	10	0	4	3	76	1.08	1	82	205
-15	-11	5	0	0	1	81	1.08	1	87	109
-20	-16	3	0	0	1	86	1.08	1	93	70
Totals		2891	2359	2673	2492					62,269

Total Operation Hours While Heating (and corrected for working days/week)	1621	44,478
Avg outdoor temp while heating (F)	42.3	

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 16

Room or Supply Air Conditions - Winter		68
Air Quantity (cfm)		1
Hour Fractions	1 AM - 9 AM	0.375
	9 AM - 5 PM	1
	5 PM - 1 AM	0.625
Operation Days Per Week		5

	Temp. Range	Hours of Occurrence 2-9	10-17	18-1	Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
70	74	115	257	222	439	-4	1.08	1	0	0
65	69	234	235	271	492	1	1.08	1	1	531
60	64	263	212	252	468	6	1.08	1	6	3,033
55	59	274	190	236	440	11	1.08	1	12	5,230
50	54	263	183	214	415	16	1.08	1	17	7,178
45	49	242	183	205	402	21	1.08	1	23	9,115
40	44	229	202	205	416	26	1.08	1	28	11,681
35	39	261	241	251	496	31	1.08	1	33	16,598
30	34	295	220	262	494	36	1.08	1	39	19,221
25	29	216	156	191	356	41	1.08	1	44	15,780
20	24	163	112	130	254	46	1.08	1	50	12,637
15	19	110	79	96	180	51	1.08	1	55	9,928
10	14	84	43	65	115	56	1.08	1	60	6,963
5	9	60	27	38	73	61	1.08	1	66	4,826
0	4	37	16	22	44	66	1.08	1	71	3,110
-5	-1	27	3	9	19	71	1.08	1	77	1,438
-10	-6	10	0	4	6	76	1.08	1	82	513
-15	-11	5	0	0	2	81	1.08	1	87	164
-20	-16	3	0	0	1	86	1.08	1	93	104
Totals		2891	2359	2673	5114					128,051

Total Operation Hours While Heating (and corrected for working days/week)	3338	91,465
Avg outdoor temp while heating (F)	42.3	

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 24

Room or Supply Air Conditions - Winter	68
Air Quantity (cfm)	1
Hour Fractions 1 AM - 9 AM	1
9 AM - 5 PM	1
5 PM - 1 AM	1
Operation Days Per Week	5

	Temp. Range	Hours of Occurrence 2-9	10-17	18-1	Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
70	74	115	257	222	594	-4	1.08	1	0	0
65	69	234	235	271	740	1	1.08	1	1	799
60	64	263	212	252	727	6	1.08	1	6	4,711
55	59	274	190	236	700	11	1.08	1	12	8,316
50	54	263	183	214	660	16	1.08	1	17	11,405
45	49	242	183	205	630	21	1.08	1	23	14,288
40	44	229	202	205	636	26	1.08	1	28	17,859
35	39	261	241	251	753	31	1.08	1	33	25,210
30	34	295	220	262	777	36	1.08	1	39	30,210
25	29	216	156	191	563	41	1.08	1	44	24,930
20	24	163	112	130	405	46	1.08	1	50	20,120
15	19	110	79	96	285	51	1.08	1	55	15,698
10	14	84	43	65	192	56	1.08	1	60	11,612
5	9	60	27	38	125	61	1.08	1	66	8,235
0	4	37	16	22	75	66	1.08	1	71	5,346
-5	-1	27	3	9	39	71	1.08	1	77	2,991
-10	-6	10	0	4	14	76	1.08	1	82	1,149
-15	-11	5	0	0	5	81	1.08	1	87	437
-20	-16	3	0	0	3	86	1.08	1	93	279
Totals		2891	2359	2673	7923					203,595

Total Operation Hours While Heating (and corrected for working days/week)	5233	145,425
Avg outdoor temp while heating (F)	42.3	

WATERVLIET ARSENAL LIMITED ENERGY STUDY

Operation Hrs/Day = 24

Room or Supply Air Conditions - Winter	68
Air Quantity (cfm)	1
Hour Fractions 1 AM - 9 AM	1
9 AM - 5 PM	1
5 PM - 1 AM	1
Operation Days Per Week	7

	Temp. Range	Hours of Occurrence 2-9	10-17	18-1	Total Hours	Delta H or T	Const.	CFM	BTU/HR	Total BTU
70	74	115	257	222	594	-4	1.08	1	0	0
65	69	234	235	271	740	1	1.08	1	1	799
60	64	263	212	252	727	6	1.08	1	6	4,711
55	59	274	190	236	700	11	1.08	1	12	8,316
50	54	263	183	214	660	16	1.08	1	17	11,405
45	49	242	183	205	630	21	1.08	1	23	14,288
40	44	229	202	205	636	26	1.08	1	28	17,859
35	39	261	241	251	753	31	1.08	1	33	25,210
30	34	295	220	262	777	36	1.08	1	39	30,210
25	29	216	156	191	563	41	1.08	1	44	24,930
20	24	163	112	130	405	46	1.08	1	50	20,120
15	19	110	79	96	285	51	1.08	1	55	15,698
10	14	84	43	65	192	56	1.08	1	60	11,612
5	9	60	27	38	125	61	1.08	1	66	8,235
0	4	37	16	22	75	66	1.08	1	71	5,346
-5	-1	27	3	9	39	71	1.08	1	77	2,991
-10	-6	10	0	4	14	76	1.08	1	82	1,149
-15	-11	5	0	0	5	81	1.08	1	87	437
-20	-16	3	0	0	3	86	1.08	1	93	279
Totals		2891	2359	2673	7923					203,595

Total Operation Hours While Heating (corrected for working days/week)	7326	203,595
Avg outdoor temp while heating (F)	42.3	

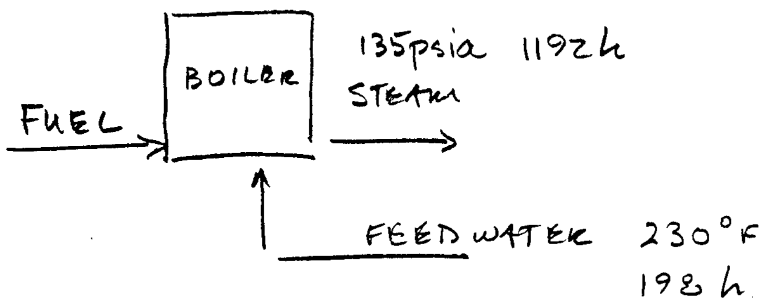
RS&H®

SUBJECT ______ AEP NO ______
SHEET ______ OF ______
DESIGNER P. Hutchinson DATE ______
CHECKER B. Todd DATE ______

BOILER PLANT EFFICIENCIES

- Calculate Average Boiler Plant Efficiency

BLDG 136



$$EFF = \frac{\text{STEAM PRODUCED}}{\text{FUEL}}$$

Data from March and April '90 were used since Boiler #3, the primary boiler, was utilized extensively.

$$EFF = \frac{(38,139,000 + 25,616,000)\# * (1192 - 198)\ Btu/\#}{(309,436 + 205,867)\ gal * 150,000\ \frac{Btu}{gal}}$$

$$= \underline{\underline{0.83}}$$

BLDG 35

Using data from August 90

$$EFF = \frac{(3676,600)\# * (1192-198)\ Btu/\#}{46,329\ ccf * 1031\ Btu/cf * 100\ cf/ccf} = \underline{\underline{0.77}}$$

ECO CALCULATION AND COST ESTIMATES

ECO CALCULATIONS AND COST ESTIMATES

TABLE OF CONTENTS

ECO 1

Power Factor Improvement

Assumptions:

1. Motors selected for power Factor improvement are operated on a regular basis.

2. The capacitors will be installed ahead of each piece of motor driven equipment.

3. Reactive electric demand charge is \$0.865/KVAR.

Calculations:

Annual Cost Savings:

Motors for buildings 20, 110 and 135 were tabulated by horsepower (details are located on pages 1-17 → 1-27.

Capacitor size recommendations were obtained from Consulting/Specifing Engineer, July 1988, Page 97, Table 3. (copy is located on page 1-14 of this appendix.

Savings = Capacitor KVAR × \$0.865/KVAR·Mo. × 12 Mo./Yr.

Savings = Capacitor KVAR × \$10.38/KVAR·Year

Savings for the motors in each building were calculated on computer spreadsheets. These calculations are located on pages 1-8 through 1-10

ECO 1 - Continued

The total savings for each building are:

Bldg. 20 :	$3,724
Bldg. 110 :	$11,325
Bldg. 135 :	$15,829

$30,878 = Total Annual Savings

Construction Cost:

A regression analysis was preformed to calculate a cost curve for the capacitors. Cost data was obtained from Means Electrical Cost Data, 1991. The regression analysis is located on page 1-7 of this appendix.

The bare material and labor costs are tabulated on pages 1-4 through 1-6.

Total Construction Cost = $130,930 (see page 1-3 for details)

Simple Payback

$$\frac{\text{Cost}}{\text{Savings}} = \frac{\$130,930}{\$30,878/\text{yr}} = \underline{\underline{4.2 \text{ years}}}$$

02/05/92

ECO Construction Cost Estimate
Calculations

ECO Name: POWER FACTOR IMPROVEMENT

ECO #: 1

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$70,131
Labor		$19.192
	Subtotal bare costs	$89,323
FICA Insurance (20% of Labor)		$3,838
Sales Tax (Not Applicable For GOGO)		$0
	Subtotal	$93,161
Overhead (15%)		$13,974
	Subtotal	$107,135
Profit (10%)		$10,714
	Subtotal	$117,849
Bond (1%)		$1,178
	Subtotal	$119,027
Contingency (10%)		$11,903
Subtotal (Construction Cost Input For LCCID *)		$130,930
SIOH (6% of Construction Cost)		$7,856
	Subtotal	$138,786
Design (6% of Construction Cost)		$7,856
Total Project Cost		$146,642

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE	DATE PREPARED 3/16/91	SHEET OF

PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
WATERVLIET Arsenal

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR W. T. Todd

CHECKED BY P. Hutchins

ECO #1 Summary SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Bldg 20	22			2533		9074	11,607
Bldg 110	55			6739		24,790	31,529
Bldg 135	83			9920		36,267	46,187
TOTAL	160			19,192		70,131	89,323

ENG FORM 150
1 AUG 59

(ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—516140

CONSTRUCTION COST ESTIMATE

DATE PREPARED	Aug. 8, 1991
SHEET	OF
PROJECT	ENERGY ENGINEERING ANALYSIS
LOCATION	Watervliet Arsenal Bldg. 20
ARCHITECT ENGINEER	REYNOLDS, SMITH AND HILLS A.E.P., INC.
BASIS FOR ESTIMATE	☒ CODE A (No design completed) ☐ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify)
DRAWING NO.	NA
ESTIMATOR	W.T. Todd
CHECKED BY	

CAPACITORS SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Capacitors, 480 V, 3Ø							
4 KVAR	0	Ea.	90	-0-	266	-0-	
5 KVAR	0	Ea.	92	-0-	277	-0-	
6 KVAR	1	Ea.	94	94	289	289	
7.5 KVAR	3	Ea.	97	291	307	921	
8 KVAR	3	Ea.	98	294	313	939	
15 KVAR	7	Ea.	112	784	395	2765	
17.5 KVAR	2	Ea.	117	234	424	848	
20 KVAR	2	Ea.	122	244	454	908	
25 KVAR	2	Ea.	133	266	513	1026	
30 KVAR	0	Ea.	143	-0-	571	-0-	
40 KVAR	2	Ea.	163	326	689	1378	
50 KVAR	0	Ea.	184	-0-	806	-0-	
180 KVAR	0	Ea.	450	-0-	2334	-0-	
Subtotals	22			#2,533		#9074	#11,607

Costs from equation derived from Means 1991 Electrical Cost Data

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

CONSTRUCTION COST ESTIMATE

DATE PREPARED: Aug. 8, 1991

SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: Watervliet Arsenal Bldg. 110

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE

- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: NA

ESTIMATOR: W. T. Todd

CHECKED BY:

CAPACITORS SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Capacitors, 480 V, 3ϕ							
4 KVAR	0	Ea.	90	-0-	266	-0-	
5 KVAR	0	Ea.	92	-0-	277	-0-	
6 KVAR	1	Ea.	94	94	289	94	
7.5 KVAR	9	Ea.	97	873	307	2763	
8 KVAR	3	Ea.	98	294	313	939	
15 KVAR	4	Ea.	112	448	395	1580	
17.5 KVAR	18	Ea.	117	2106	424	7632	
20 KVAR	0	Ea.	122	-0-	454	-0-	
25 KVAR	12	Ea.	133	1596	513	6156	
30 KVAR	3	Ea.	143	429	571	1713	
40 KVAR	1	Ea.	163	163	689	689	
50 KVAR	4	Ea.	184	736	806	3224	
180 KVAR	0	Ea.	450	-0-	2334	-0-	
Subtotals	55			#6,739		#24,790	#31,529

Costs from equation derived from Means 1991 Electrical Cost Data

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

CONSTRUCTION COST ESTIMATE

DATE PREPARED: Aug. 8, 1991
SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: Watervliet Arsenal Bldg. 135

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.: NA

ESTIMATOR: W.T. Todd

CHECKED BY:

CAPACITORS SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Capacitors, 480 V, 3∅							
4 KVAR	0	Ea.	90	-0-	266	-0-	
5 KVAR	0	Ea.	92	-0-	277	-0-	
6 KVAR	17	Ea.	94	1598	289	4913	
7.5 KVAR	14	Ea.	97	1358	307	4298	
8 KVAR	8	Ea.	98	784	313	2504	
15 KVAR	10	Ea.	112	1120	395	3950	
17.5 KVAR	6	Ea.	117	702	424	2544	
20 KVAR	10	Ea.	122	1220	454	4540	
25 KVAR	9	Ea.	133	1197	513	4617	
30 KVAR	5	Ea.	143	715	571	2855	
40 KVAR	2	Ea.	163	326	689	1378	
50 KVAR	0	Ea.	184	-0-	806	-0-	
180 KVAR	2	Ea.	450	900	2334	4668	
Subtotals	83			$9,920		$36,267	$46,187

Costs From equation derived from Means 1991 Electrical Cost Data

ENG FORM 150
1 AUG 59

(ER 1110-345-730)

PREVIOUS EDITION MAY BE USED

(TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—516146

Power Factor Improvement
For Electric Motor Driven Equipment
Filename: CAP-COST

08/08/91

Regression Analysis Data

Capactitor KVAR	Bare Labor Cost From 1991 Means	Bare Matl. Cost From 1991 Means	Total Cost
5.0	$100	$276	$376
7.5	$100	$295	$395
10.0	$100	$345	$445
15.0	$100	$405	$505
20.0	$125	$450	$575
30.0	$135	$560	$695
40.0	$170	$710	$880
50.0	$185	$795	$980

Regression Analysis Output

	Labor	Material
Constant	81.4	218.7
X Coefficient	2.050	11.754
Standard Error of Coefficient	0.176	0.304
Standard Error of Y Estimate	7.6	13.2
R Squared	0.958	0.996
Number of Observations	8	8
Degrees of Freedom	6	6

Capacitor Cost Equations:

Labor Cost = $81.4 + $2.050/KVAR * Capacitor KVAR

Material Cost = $218.7 + $11.754/KVAR * Capacitor KVAR

Power Factor Improvement - Building 20 08/08/91
For Electric Motor Driven Equipment
Filename: CAP-20R

Motor HP	Number Motors	Recommended KVAR (1)	Labor Cost (2)	Material Cost (2)	Annual Cost Savings (3)
800	0	180	0	0	0
700	0	170	0	0	0
600	0	150	0	0	0
500	0	120	0	0	0
450	0	90	0	0	0
400	0	80	0	0	0
350	0	75	0	0	0
300	0	70	0	0	0
250	0	60	0	0	0
200	0	50	0	0	0
150	2	40	327	1378	822
125	0	35	0	0	0
100	0	30	0	0	0
75	2	25	265	1025	514
60	2	20	245	908	411
50	2	17.5	235	849	360
40	7	15	785	2765	1079
30	3	8	293	938	247
25	3	7.5	290	921	231
20	1	6	94	289	62
Totals	22		2534	9072	3724

$$\text{Simple payback} = \frac{11{,}606\ \$}{3{,}724\ \$/\text{yr}} = 3.12\ \text{Year(s)}$$

(1) Consulting/Specifing Engineer, July 1988, page 97, Table 3 for 1800 rpm, 4 pole motors.

(2) Cost curve derived from Means Electrical Cost Data, 1991 Refer to regression analysis in this section.

(3) For a reactive electric demand charge of $0.865 per KVAR.

Power Factor Improvement - Building 110
For Electric Motor Driven Equipment
Filename: CAP-110R

08/08/91

Motor HP	Number Motors	Recommended KVAR (1)	Labor Cost (2)	Material Cost (2)	Annual Cost Savings (3)
800	0	180	0	0	0
700	0	170	0	0	0
600	0	150	0	0	0
500	0	120	0	0	0
450	0	90	0	0	0
400	0	80	0	0	0
350	0	75	0	0	0
300	0	70	0	0	0
250	0	60	0	0	0
200	4	50	736	3226	2054
150	1	40	163	689	411
125	0	35	0	0	0
100	3	30	429	1714	924
75	12	25	1592	6151	3082
60	0	20	0	0	0
50	18	17.5	2111	7639	3236
40	4	15	449	1580	616
30	3	8	293	938	247
25	9	7.5	871	2762	693
20	1	6	94	289	62
Totals	55		6737	24987	11325

$$\text{Simple payback} = \frac{31{,}724\ \$}{11{,}325\ \$/\text{yr}} = 2.80 \quad \text{Year(s)}$$

(1) Consulting/Specifing Engineer, July 1988, page 97, Table 3 for 1800 rpm, 4 pole motors.

(2) Cost curve derived from Means Electrical Cost Data, 1991 Refer to regression analysis in this section.

(3) For a reactive electric demand charge of $0.865 per KVAR.

Power Factor Improvement - Building 135 08/08/91
For Electric Motor Driven Equipment
Filename: CAP-135R

Motor HP	Number Motors	Recommended KVAR (1)	Labor Cost (2)	Material Cost (2)	Annual Cost Savings (3)
800	2	180	901	4669	3698
700	0	170	0	0	0
600	0	150	0	0	0
500	0	120	0	0	0
450	0	90	0	0	0
400	0	80	0	0	0
350	0	75	0	0	0
300	0	70	0	0	0
250	0	60	0	0	0
200	0	50	0	0	0
150	2	40	327	1378	822
125	0	35	0	0	0
100	5	30	715	2857	1541
75	9	25	1194	4613	2311
60	10	20	1224	4538	2054
50	6	17.5	704	2546	1079
40	10	15	1122	3950	1541
30	8	8	782	2502	657
25	14	7.5	1355	4296	1079
20	17	6	1593	4917	1048
Totals	83		9915	36265	15829

$$\text{Simple payback} = \frac{46{,}180\ \$}{15{,}829\ \$/\text{yr}} = 2.92 \quad \text{Year(s)}$$

(1) Consulting/Specifing Engineer, July 1988, page 97, Table 3 for 1800 rpm, 4 pole motors.

(2) Cost curve derived from Means Electrical Cost Data, 1991 Refer to regression analysis in this section.

(3) For a reactive electric demand charge of $0.865 per KVAR.

Power Factor Calculation
Filename: PFCALC
Data For: Feb-91

INPUTS		
Metered On Peak KW	10432.3	KW
Metered KVAR	8448.0	KVAR
Billed KVAR	4992.0	KVAR
Cost Per KVAR	0.85551	$/KVAR

OUTPUTS		
Current KVA	13423.9	KVA
Current PF	0.777	
Allowable KVA	10989.9	KVA
Allowable PF	0.949	
Allowable KVAR	3456.0	KVAR
Billed KVAR	4992.0	KVAR
Billed Amount	$4,270.71	

KVA = (KW^2+KVAR^2)^0.5
PF = KW/KVA

Source: WVA February 1991 Electric Bill

Power Factor Calculation
Filename: PFCALC
Data For: Aug-90

INPUTS		
Metered On Peak KW	11011.9	KW
Metered KVAR	9120.0	KVAR
Billed KVAR	5472.0	KVAR
Cost Per KVAR	0.80851	$/KVAR

OUTPUTS		
Current KVA	14298.1	KVA
Current PF	0.770	
Allowable KVA	11600.4	KVA
Allowable PF	0.949	
Allowable KVAR	3648.0	KVAR
Billed KVAR	5472.0	KVAR
Billed Amount	$4,424.17	

KVA = (KW^2+KVAR^2)^0.5
PF = KW/KVA

Source: WVA August 1990 Electric Bill

Power Factor Calculation
Filename: PFCALC
Data For: Sep-90

INPUTS		
Metered On Peak KW	11205.0	KW
Metered KVAR	8832.0	KVAR
Billed KVAR	5120.0	KVAR
Cost Per KVAR	0.80851	$/KVAR

OUTPUTS		
Current KVA	14267.3	KVA
Current PF	0.785	
Allowable KVA	11803.9	KVA
Allowable PF	0.949	
Allowable KVAR	3712.0	KVAR
Billed KVAR	5120.0	KVAR
Billed Amount	$4,139.57	

KVA = (KW^2+KVAR^2)^0.5
PF = KW/KVA

Source: WVA September 1990 Electric Bill

TO: ODP-I
MIKE MIZENKO

SMCWV-EHE

28 January 1986

MEMORANDUM FOR RECORD

SUBJECT: Strip Chart Readings

1. Strip Chart Readings taken during the weeks of 23 and 30 Dec 1985 indicate that some equipment is running significantly below the previously assumed load values.

BLDG NO.	EQUIPMENT	ASSUMED HP	READING HP	%
25	OMNI 20	40	20	50
35	WOHLENBERG	125	32	25
135	RD&D H.S. LATHE, B, NORTH	200	60 (77AMPS)	30
135	RD&D LATHE, C. NORTH	200	42 (55AMPS)	21
135	HONE, B. SOUTH	100	35 (46AMPS)	35
135	SWAGE	100	100 (124AMPS)	100
		765	289	→ 38% Average

2. Five of these machine readings indicate that additional testing under maximum load conditions is warranted.

Bill

BILL FACE
Engineering Division

MIKE,

THESE VALUES DO NOT REDUCE THE MFG. CONNECTION RATINGS, BUT WILL ALLOW MORE EQUIPMENT CONNECTIONS PER BUS DUCT THAN PREVIOUSLY CALCULATED.

Bill

TABLE 2
SUGGESTED MAXIMUM CAPACITOR RATINGS—"T-FRAME" NEMA "DESIGN B" MOTORS*

Induction motor horsepower rating	Number of poles and nominal motor speed in rpm											
	2 3,600 rpm		4 1,800 rpm		6 1,200 rpm		8 900 rpm		10 720 rpm		12 600 rpm	
	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent	Capacitor kvar	Current reduction percent
2	1	14	1	24	1.5	30	2	42	2	40	3	50
3	1.5	14	1.5	23	2	28	3	38	3	40	4	49
5	2	14	2.5	22	3	26	4	31	4	40	5	49
7½	2.5	14	3	20	4	21	5	28	5	38	6	45
10	4	14	4	18	5	21	6	27	7.5	36	8	38
15	5	12	5	18	6	20	7.5	24	8	32	10	34
20	6	12	6	17	7.5	19	9	23	10	29	12.5	30
25	7.5	12	7.5	17	8	19	10	23	12.5	25	17.5	30
30	8	11	8	16	10	19	15	22	15	24	20	30
40	12.5	12	15	16	15	19	17.5	21	20	24	25	30
50	15	12	17.5	15	20	19	22.5	21	22.5	24	30	30
60	17.5	12	20	15	22.5	17	25	20	30	22	35	28
75	20	12	25	14	25	15	30	17	35	21	40	19
100	22.5	11	30	14	30	12	35	16	40	15	45	17
125	25	10	35	12	35	12	40	14	45	15	50	17
150	30	10	40	12	40	12	50	14	50	13	60	17
200	35	10	50	11	50	11	70	14	70	13	90	17
250	40	11	60	10	60	10	80	13	90	13	100	17
300	45	11	70	10	75	12	100	14	100	13	120	17
350	50	12	75	8	90	12	120	13	120	13	135	15
400	75	10	80	8	100	12	130	13	140	13	150	15
450	80	8	90	8	120	10	140	12	160	14	160	15
500	100	8	120	9	150	12	160	12	180	13	180	15

*For use with 3-phase, 60 hertz NEMA Classification B Motors to raise full load power factor to approximately 95%

Courtesy of Commonwealth Sprague Capacitor Inc.

TABLE 3
MULTIPLIERS TO DETERMINE CAPACITOR KILOVARS REQUIRED FOR POWER-FACTOR CORRECTION

Original power factor	Corrected power factor																				
	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.0
0.50	0.982	1.008	1.034	1.060	1.086	1.112	1.139	1.165	1.192	1.220	1.248	1.276	1.306	1.337	1.369	1.403	1.440	1.481	1.529	1.589	1.732
0.51	0.937	0.962	0.989	1.015	1.041	1.067	1.094	1.120	1.147	1.175	1.203	1.231	1.261	1.292	1.324	1.358	1.395	1.436	1.484	1.544	1.687
0.52	0.893	0.919	0.945	0.971	0.997	1.023	1.050	1.076	1.103	1.131	1.159	1.187	1.217	1.248	1.280	1.314	1.351	1.392	1.440	1.500	1.643
0.53	0.850	0.876	0.902	0.928	0.954	0.980	1.007	1.033	1.060	1.088	1.116	1.144	1.174	1.205	1.237	1.271	1.308	1.349	1.397	1.457	1.600
0.54	0.809	0.835	0.861	0.887	0.913	0.939	0.966	0.992	1.019	1.047	1.075	1.103	1.133	1.164	1.196	1.230	1.267	1.308	1.356	1.416	1.559
0.79	0.026	0.052	0.078	0.104	0.130	0.156	0.183	0.209	0.236	0.264	0.292	0.320	0.350	0.381	0.413	0.447	0.484	0.525	0.573	0.633	0.776
0.80	0.000	0.026	0.052	0.078	0.104	0.130	0.157	0.183	0.210	0.238	0.266	0.294	0.324	0.355	0.387	0.421	0.458	0.499	0.547	0.609	0.750
0.81		0.000	0.026	0.052	0.078	0.104	0.131	0.157	0.184	0.212	0.240	0.268	0.298	0.329	0.361	0.395	0.432	0.473	0.521	0.581	0.724
0.82			0.000	0.026	0.052	0.078	0.105	0.131	0.158	0.186	0.214	0.242	0.272	0.303	0.335	0.369	0.406	0.447	0.495	0.555	0.698
0.83				0.000	0.026	0.052	0.079	0.105	0.132	0.160	0.188	0.216	0.246	0.277	0.309	0.343	0.380	0.421	0.469	0.529	0.672
0.84					0.000	0.026	0.053	0.079	0.106	0.134	0.162	0.190	0.220	0.251	0.283	0.317	0.354	0.395	0.443	0.503	0.646
0.85						0.000	0.027	0.053	0.080	0.108	0.136	0.164	0.194	0.225	0.257	0.291	0.328	0.369	0.417	0.477	0.620
0.86							0.000	0.026	0.053	0.081	0.109	0.137	0.167	0.198	0.230	0.264	0.301	0.342	0.390	0.450	0.593
0.87								0.000	0.027	0.055	0.083	0.111	0.141	0.172	0.204	0.238	0.275	0.316	0.364	0.424	0.567
0.88									0.000	0.028	0.056	0.084	0.114	0.145	0.177	0.211	0.248	0.289	0.337	0.397	0.540
0.89										0.000	0.028	0.056	0.086	0.117	0.149	0.183	0.220	0.261	0.309	0.369	0.512
0.90											0.000	0.028	0.058	0.089	0.121	0.155	0.192	0.233	0.281	0.341	0.484
0.91												0.000	0.030	0.061	0.093	0.127	0.164	0.205	0.253	0.313	0.456
0.92													0.000	0.031	0.063	0.097	0.134	0.175	0.223	0.283	0.426
0.93														0.000	0.032	0.066	0.103	0.144	0.192	0.252	0.395

Courtesy of Commonwealth Sprague Capacitor Inc.

Power Factor Improvement 08/08/91
For Electric Motor Driven Equipment
Filename: CAPTABL2

Motor HP	Number Motors	Recommended KVAR (1)	Capacitor Cost (2)	Annual Cost Savings (3)	Simple Payback
800	1	180	4077	1849	2.2
700	1	170	3875	1746	2.2
600	1	150	3471	1541	2.3
500	1	120	2864	1233	2.3
450	1	90	2258	924	2.4
400	1	80	2056	822	2.5
350	1	75	1955	770	2.5
300	1	70	1854	719	2.6
250	1	60	1652	616	2.7
200	1	50	1450	514	2.8
150	1	40	1248	411	3.0
125	1	35	1147	360	3.2
100	1	30	1046	308	3.4
75	1	25	945	257	3.7
60	1	20	844	205	4.1
50	1	17.5	793	180	4.4
40	1	15	742	154	4.8
30	1	8	601	82	7.3
25	1	7.5	591	77	7.7
20	1	6	561	62	9.1
15	1	5	540	51	10.5
10	1	4	520	41	12.7
7.5	1	3	500	31	16.2
5	1	2.5	490	26	19.1
3	1	1.5	470	15	30.5
2	1	1	460	10	44.7
Totals	26		37008	13004	2.8

(1) Consulting/Specifing Engineer, July 1988, page 97, Table 3 for 1800 rpm, 4 pole motors.
(2) Cost curve derived from Means Electrical Cost Data, 1991 Refer to regression analysis below. 46.4 % markup added.
(3) For a reactive electric demand charge of $0.865 per KVAR.

Regression Data

Capact. KVAR	Cost From Means
5	376
7.5	395
10	445
15	505
20	575
30	695
40	880
50	980

Regression Output

Constant	300.1
Std Error of Y Estimate	15.4
R Squared	0.996
No. of Observations	8
Degrees of Freedom	6
X Coefficient	13.80
Std Err of Coefficient	0.356

Industrial Applications

Application and Benefits

A low power factor means higher costs and reduced efficiency Chances are that power factor in your plant is low

Approximately one-half of all plants have a power factor below 85 percent. Low power factor wastes money directly in higher electric bills, and indirectly by reducing the efficiency of plant distribution systems and the productive equipment they serve.

ABB capacitors can benefit your power system in four major ways:

1. Raise power factor . . . you avoid premium charges and power-factor penalties on your electric bill.
2. Increase system capacity . . . you are able to operate more equipment without increasing the peak-demand charge.
3. Provide higher, more uniform voltage levels . . . you have more effective lighting and improved motor performance.
4. Reduce line current . . . you lower the electric losses in lines and equipment between the power source and your capacitors.

- Dry dielectric system – no free fluid
- Environmentally safe
- Reduced fire risk
- Reduced losses
- Self healing
- Sequential protection

In addition to improving power factor capacitors also:

- Improve voltage @ transformer due to capacitor addition:

$$\text{\% voltage rise} = \frac{\text{kVAR of capacitors} \times \text{\% reactance of transformer}}{\text{kVA of transformer}}$$

Note: system reactance should be added to the transformer reactance if available.

- Reduce power losses in the distribution system due to capacitor addition:

$$\text{\% reduction of losses} = 100 - 100 \left(\frac{\text{original power factor}}{\text{improved power factor}}\right)^2$$

Derating Capacitors

- Reduce kVAR when operating 60 Hz unit @ 50 Hz

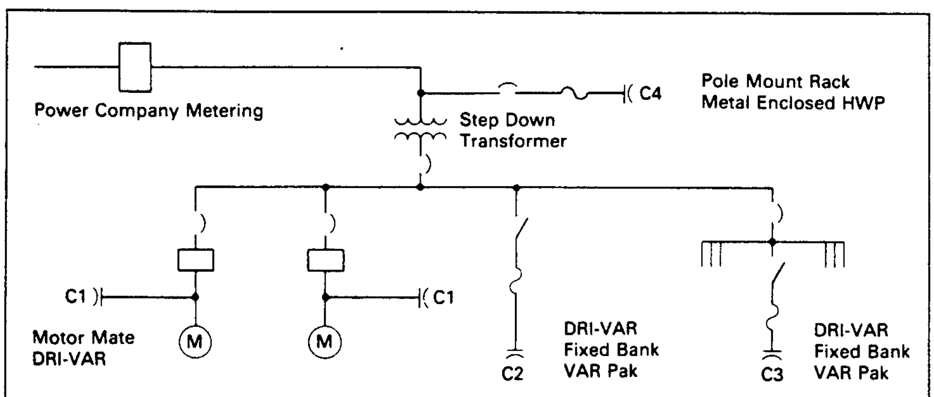
$$\text{Actual kVAR} = \text{rated kVAR} \left(\frac{50}{60}\right) = .83 \text{ rated kVAR}$$

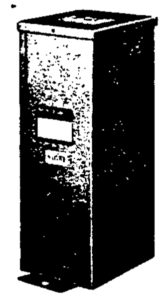
- Reduce kVAR when operating @ below rated voltage

$$\text{Actual kVAR} = \text{rated kVAR} \left(\frac{\text{operating voltage}}{\text{rated voltage}}\right)^2$$

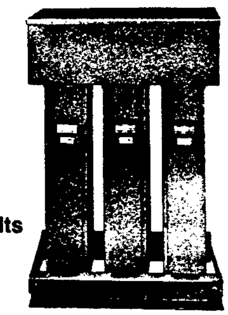
i.e.
240V @ 208 = .751 rated kVAR

Typical One-Line Diagram Showing Capacitor Locations

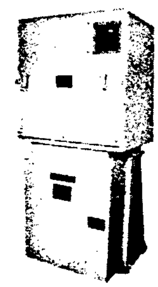




DRI-VAR
Power Capacitor
240, 480, 600 Volts



DRI-VAR
Fixed Bank
240, 480, 600 Volts



VAR-PAK
Var-Controlled Automatic Switched Capacitor Bank
240, 480, 600 Volts

HWP With CLC Fuses
2400 and 4160 Volts
25-800 kVAR

Two-Unit HWP
2400 and 4160 Volts
25-800 kVAR

HWP
2400 and 4160 Volts
25-800 kVAR

Watervliet Arsenal
Building 135 Motor List
Filename: MOTORLST

WVA # -)	11760	11700	12441	11770	12270	12111	12260	12177	11640	10277	12006	9390	11190	12289	
No.Ea.-)	1	1	1	1	3	5	8	6	4	3	2	1	2	4	
No.Op.-)	1	1	1	1	3	3	3	3	3	1	1	1	2	3	
Motor HP					# Motors							# Motors			TOTALS
800		2													2
250															0
200															0
150		2													2
125															0
100				1						4					5
75					1		1	1							3
60		8											1		9
50						1								1	2
40	1	6						1							8
30		2		2					1			1			6
25		4		2					2				1		9
20	1	6		1				2	1						11
15															0
10	2			1									1		4
7.5		4					4	1	1	1					11
5		5					1	1				1	1		9
3	3	1		2	1		4	1	1				2		15
2					2	2			1					1	6
1.5						1	2	2	1					1	7
1	6	3					1		1			1	1	4	17
0.75	2				1			1				2		2	8
0.5					4	1	1	2			7	4	1	4	24
0.33					1			1	1						3
0.25					1	1	4	1					2	1	10
0.125						1	4							1	6
	15	43	0	9	11	7	22	14	10	5	7	9	10	15	177
TOTALS															
	15	43	0	9	33	21	66	42	30	5	7	9	20	45	345

61

Equipment List

By Process		By WV Number	
Equipment	WV Number	Equipment	WV Number
Indu. Furnace	11760	Press	9390
Rotary Forge	11700	Swage	10277
Abrasive Saw	12441	Lathe	11190
Selas Furnace	11770	Hone	11640
Press	12270	Hone	11640
Lathe	12111	Rotary Forge	11700
Lathe	12260	Indu. Furnace	11760
Lathe	12177	Selas Furnace	11770
Hone	11640	Pit Furnace	12006
Swage	10277	Lathe	12111
Pit Furnace	12006	Lathe	12177
Press	9390	Lathe	12260
Lathe	11190	Press	12270
Hone	11640	Lathe	12289
Lathe	12289	Abrasive Saw	12441

Equipment List

By Process		By WV Number	
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Indu. Furnace	11760	Press	9390
Rotary Forge	11700	Swage	10277
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Selas Furnace	11770	Hone	11640
Press	12270	Hone	11640
Lathe	12111	Rotary Forge	11700
Lathe	12260	Indu. Furnace	11760
Lathe	12177	Selas Furnace	11770
Hone	11640	Pit Furnace	12006
Swage	10277	Lathe	12111
Pit Furnace	12006	Lathe	12177
Press	9390	Lathe	12260
Lathe	11190	Press	12270
Hone	11640	Lathe	12289
Lathe	12289	Abrasive Saw	12441

Watervliet - Bldg. 110 - Substation Loading 11/15/84
Assume Peak Production

SECTION 2 B1-A

480 V.A.C.

ITEM	LOAD (HP)	FLA	DEMAND @ .8
P.C. GRINDER	62 HP	75	60.0 A.
P.C. GRINDER	62	75	60.0
ENGINE LATHE	50	65	52.0
BORING LATHE	66 1/3	80	64.0
CONV. BORE	53 1/6	67	53.6
SPOTTING LATHE	75	96	76.8
ENGINE LATHE	75	96	76.8
PRESS	36 3/4	46	36.8
HORIZ. HONES	182 1/2	230	184.0
SWAGE	200	240	192.0
RIFLER	57 1/2	58	46.4
CONV. BORE	52	66	52.8
GUIDED BORE	303	365	292.0
GUIDED BORE	303	365	292.0

Large Machine Sub-Total	$1538.8A \times \frac{480\sqrt{3}}{1000}$ =	1277 KW
+ 3 Small Machines @ 10HP ea.	$(14A \times 3) \times \frac{480\sqrt{3}}{1000}$ =	35 KW
+ BLDG. 121	390.0 →	390 KW
+ French Lathe (125HP assume)	150.0 →	150 KW
+ Ltg., outlets & Misc.	100.0 →	100 KW
Sub-Total		1952 KW
Diversity @ .8		1562 KW
+ 30% Future Capacity		469 KW
Total		2031 KW

@ .8 P.F. = 2539 KVA.

SMALL MACH.
↓
3

G+G Report

Watervliet - Bldg. 110 - Substation Loading
ASSUME Peak PRODUCTION

11/15/84

SECTION 2B1

480 V.A.C.

ITEM	LOAD (HP)	FLA	DEMAND @ .8
open	—	–	—
Horiz. Hone	25 HP	34	27.2 A.
Conv Bore	7 3/4	11	8.8
Heller Milling	(200 Amps)	200	160.0
Rifler	27 1/2	37	29.6
Radial Drill	17 1/16	30	24.0
Rifler	27 1/2	37	29.6
↓	—	—	
Planer Mills	31 1/2	40	32.0
—	—	–	—
Drill Press Riveter	4 3/4, 2	10	8.0

Large machine sub-total 319.2 A $\times \frac{480\sqrt{3}}{1000}$ = 265 KW
+ 55 small machines @ 10 HP ea (14 FLA × 55 = 770 × $\frac{480\sqrt{3}}{1000}$ = 639 KW
+ LTG., outlets, & misc. 160.0 KW → 100 KW
+ Pit Furnace 600.0 KW → 600 KW

SUB-TOTAL 1604 KW

SMALL MACH.
↓
55

Diversity @ .8 1283 KW
+30% Future Capacity → 385 KW

TOTAL 1668 KW

@ .8 P.F. 2085 KVA

G+G report

Watervliet - Bldg. 110 — Substation Loading
Assume Peak Production

11/15/84

SECTION 2A2

480V, A.C.

ITEM	LOAD (HP)	FLA	DEMAND @ .8
PLANER MILL	27 HP	36	28.8 A.
PLANER MILL	41½	52	41.6
GRINDER	62	77	61.6
BELT GRINDER	57	75	60.0
ENGINE LATHE	75	96	76.8
GRINDER	20	27	21.6
RIFLER	55	57	45.6
Grinder	57	58	46.4
HONE, RIFLER	55½, 77¾	154	123.2
BORE	303	365	292.0
BORE	303	365	292.0
ENGINE LATHE	75	96	76.8
GRINDER	26	35	28.0
HONE	50	65	52.0
ENGINE LATHE	75	96	76.8
P.C. LATHE	57¼	58	46.4

Large Machine Subtotal — 1369.6 A × $\frac{480 V \sqrt{3}}{1000}$ =	1137.0	KW	
+ 66 Small Machine @ 10 HP ea. (14 A. FLA ea.)	767.0	KW	
LTG., OUTLETS, MISC. →	100.0	KW	
Bldg 108	100.0	KW	(assumed)
Quarters 1-6	100.0	KW	(")
Quarters # 8	50.0	KW	(")
Bldg # 10 (2 Feeds)	300.0	KW	(")

SMALL MACH.
↓
66

Sub-total	2554	KW
Diversity x .8	2043	KW
+ 30% Future Capacity	613	KW
Total	2656	KW

@ .8 P.F. = 3320 KVA.

Recommendation: Replace 2A2 with double ended sub-station rated at 2000 KVA ea. Transformer.

G+G Report

Watervliet - Bldg 110 - Substation Loading
ASSUME Peak Production.

11/15/84

SECTION 1A3

480V.A.C.

ITEM	LOAD (HP)	FLA	DEMAND @ .8
SPIN., P.C. LATHE	~~57¼~~, 53⅙ HP	142	113.6 A.
ENGINE LATHE	75	96	76.8
ENGINE LATHE	75	96	76.8
GRINDER, P.C. GRIND	62, 62	150	120.0
PRESS	36¾	50	40.0
QUALITY CONTROL - NO HOLDING AREAS	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
	-		
P.C. LATHE	57¼	75	60.0
P.C. LATHE	57¼	75	60.0
GRINDER	57	75	60.0

LARGE MACHINE SUBTOTAL 607.2A. x $\frac{480\sqrt{3}}{1000}$ →	504.0 KW
+ 14 SMALL MACHINES @ 10HP ea. (14 FLA/ea) =	163.0
+ D.C. EQUIPMENT (CRANES & COMPRESSORS)	480.0
+ SHRINK PIT HEATERS & MTRS	80.0
+ LTG., OUTLETS & MISC.	200.0
+ Bldg 115 Computer Rm.	100.0 (ASSUMED)
+ HI-BAY LTG.	200.0

SMALL MACH.
↓
14

Sub-total →	1727. KW
DIVERSITY @ .8	1382 KW
+ 30% FUTURE CAPACITY	415 KW
TOTAL	1797 KW

@ .8 P.F. = 2246 KVA.

G+G Report

Bldg 110 Motor Data From G+G Rpt.

	HP	Assumed Sizes
Spindle	57.25	50, [illegible], 2, 1/4
DC lathe	53.17	50, 3, 1/6
Engine lathe	75	75
" "	75	75
PC Grinder	62	50, 10, 2
" "	62	50, 10, 2
Press	36.75	30, 5, 1, 3/4
PC lathe	57.25	50, 5, 2, [illegible]
PC lathe	57.25	50, 5, 2, 1/4
Grinder	57	50, 5, 2
14 Small Mach	~10 hp (each)	< 10 x 14
Planer Mill	27	25, 2
" "	41.5	40, 1, 1/2
Grinder	62	50, 10, 2
"	20	20
"	26	25, 1
Belt Grinder	57	50, 5, 2
Engine lathe	75	75
" "	75	75
" "	75	75
Rifler	55	50, 5
Grinder	57	50, 5, 2
Hone	55.5	50, 5, 1/2
Rifler	77.75	75, 7.5, ~~4~~
Bore	303	200, 75, 25, ~~3~~
"	303	200, 75, 25, ~~3~~

Bldg 110 continued

Hone	50	
PC lathe	57.25	50, 5, 2, 1/4
66 Small Mach.	~10 hp (each)	10 x 66
Horiz. Hone	25	25
Conv. Bore	7.75	5, 2, 3/4
Heller Milling	~150 hp	100, 40, 5, 3, 2
Rifler	27.5	25, 2, 1/2
"	27.5	25, 2, 1/2
~~x~~	—	—
Radial Drill	17	15, 2
Planer Mill	31.5	30, 1, 1/2
Drillpress	4.75	4, 3/4
Riveter	2	~~2~~
55 sm mach	10 hp (each)	10 x 55
PC Grinder	62	50, 10, 2
" "	62	50, 10, 2
Engine lathe	50	50
Boring lathe	66.33	50, 10, 5, 1, 1/3
Conv. Bore	53.17	40, 10, 3, 1/6
Spotting Lathe	75	75
Engine Lathe	75	75
Press	36.75	30, 5, 1, 3/4
Horiz. Hone	182.5	150, 25, 5, 2, 1/2
Swage	200	100, 100
Rifler	57.5	50, 5, 2, 1/2
Conv. Bore	52	50, 2
Guided Bore	303	200, 75, 25, 3
" "	303	+ 3 sm mach @ 10hp ea

Bldg 110 Motor Totals

HP	# motors
200	4
150	1
100	3
75	12
60	-0-
50	18
40	4
30	3
25	9
20	1
15	1
10	143

(2) - MACHING RUNING AT 80% OF NAMEPLATE RATING AND A DEMAND FACTOR OF 80% FOR 64% DERATING FROM CONNECTED LOAD TO MAXIMUM LOAD

(1) - SEE J ... SECT II

WATERVLIET NO. 7/Bldg 20 (1)

Equipment Load Density Calculation.

1/30/85
D. Backberg

Calculation based on Plant Layout of equipment in area bordered by columns D and F - 5 and 9. Equipment loads provided by Plant Layout, consider no diversity and 80% demand factor.

ITEM	HP.	FLA	Load @ .8 DF
Horizontal Mill	20	27	22
Radial Arm Drill	3	5	4
Verticle Mill	15	21	17
Verticle Turret Lathe	30	40	32
Horizontal Gun Drill	30	40	32
Surface Grinder	40	52	42
Horizontal Broach	42	52	42
Thread Mill	25	34	27
Thread Mill	25	34	27
Verticle Turret Lathe	45	60	48
Thread Mill	25	34	27
Verticle Turret Lathe	30	40	32
Duplex Mill	7.5	11	9
Verticle Turret Lathe	40	52	42
Surface Grinder	15	21	17
Heavy Verticle Lathe		320	256
Machining Center	15	21	17
Broach Colonial		320	256
Rotary Grinder	40	52	42
Rotary Grinder	60	77	62
NC Profile Mill	50	65	52
Verticle Turret Lathe	60	77	62
NC Profile Lathe	50	65	52
Horizontall Broach	40	52	42
Profile Mill	45	62	50

LOAD WITHOUT TWO LARGEST = 800A = 665KVA

665 X .8 X .8 = 426KVA (2)

PER 19,200 S.F. = 22.2VA/S.F.

VS.

45.3 VA/S.F.

New Equip. now being installed 400A Disc

400 A. Disc

From G+G Report

TOTAL 1311 Amps. $\times \frac{480\sqrt{3}}{1000} \times .8$ DIVERSITY = 870KW

1-25

Area: 120' x 160' = 19,200 ft²

Density = $\frac{870KW}{19200ft^2}$ = 45.3 w/ft² for Equipment

Bldg. 20 — Motor Data from G & G Report — Assumed Sizes

Bldg. 20	Motor Data from G & G Report	Assumed Sizes
Horizontal Mill	20	20
Radial Arm Drill	3	3
Verticle Mill	15	15
Verticle Turret Lathe	30	30
Horiz. Gun Drill	30	30
Surf. Grinder	40	40
Horiz. Broach	42	40, 2
Thread Mill	25	25
" "	25	25
Verticle Turret Lathe	45	40, 5
" " "	30	30
" " "	40	40
" " "	60	60
Thread Mill	25	25
Duplex Mill	7.5	7.5
Surface Grinder	15	15
Hessap Vert. Lathe	~240	150, 75, 10, 5
Machining Center	15	15
Rotary Grinder	40	40
" "	60	60
NC Profile Mill	30	30
" " Lathe	50	50
Horiz. Broach	40	40
Profile Mill	45	40, 5
Broach Colonial	~240	150, 75, 10, 5

Bldg 20 Motor totals

HP	# Motors
150	2
75	2
60	2
50	2
40	7
30	3
25	3
20	1
15	3
10	2
Total	27

[illegible]
\- 7
27

SUBJECT	ECO# 2 NGAS Fuel Switch
DESIGNER	P. Hutchins
CHECKER	B. Todd
AEP NO	290-0379-002
SHEET	OF
DATE	8/8/91
DATE	9/16/91

RS&H®

- Calculate dollar savings

	FY90 Use (MBTU)	FY91 Avg. Rate $/MBTU	Est. FY91 Cost $
#6 Fuel Oil	278,000	$6.61	$1,837,580
Nat. Gas	278,000	$4.66	$1,295,480
Annual Savings			$542,100

RS&H ® SUBJECT	Natural Gas Pipeline ECO #2	AEP NO	290-0379-002
		SHEET	OF
DESIGNER	P. Hutchins	DATE	11/11/91
CHECKER		DATE	

Natural Gas Pipeline

- Determine pipe line size
- Calculate the natural gas peak flow:

Peak steam demand is ~ 120,000 #/hr 120 psig
(based on conversations with WVA personnel)

$$\frac{120{,}000\ \#/hr \cdot (1192-118)\ Btu/lb}{0.80} = 161\ MBtu/hr$$

- Convert to MCF (thousands of cf)

$$\frac{161 \times 10^6\ Btu/hr}{1030\ Btu/cf} * \frac{1\ mcf}{1000\ cf} = 156\ \frac{mcf}{hr}$$

- Add 16 MBtu/hr for cogeneration

$$\frac{16E6}{1030}\ \frac{1}{1000} = 16\ \frac{mcf}{hr}$$

- Plus contingency (10%)

$$(156 + 16) * 1.1 = 190\ \frac{mcf}{hr},\ \text{say } 200\ \frac{mcf}{hr}$$

RS&H®

SUBJECT Nat Gas Line

DESIGNER P. Hutchins

CHECKER

AEP NO

SHEET OF

DATE 11/11/91

DATE

- Calculate required pipe diameter

Inlet pressure minimum is 50 psig
Exit pressure minimum is 10 psig

Maximum ΔP = 40 psig

· Calculate ΔP through various pipe sizes

Use nomographs from Crane's, Flow of Fluids

Given :

Natural gas specific gravity	=	0.75
Flow rate	=	200,000 cfh
Pressure	=	50 psig
Temp.	=	60°F
Density (natgas)	=	0.23 lbs/cf
Flow	=	46,000 lb/hr
Density (air)	=	0.335 lbs/cf
S_g	=	0.69
Flow rate	=	

- Convert to standard conditions:

$\rho_1 V_1 = \rho_2 V_2$ $\quad \rho_1 = 0.23\#/cf \quad \rho_2 = 0.053\#/cf$
$\quad V_1 = 200{,}000$ cfh

$$V_2 = \frac{\rho_1 V_1}{\rho_2} = \frac{0.23}{0.053}(200{,}000) = 867{,}924 \text{ scfh}$$

SUBJECT Nat. Gas Line
AEP NO
SHEET OF
RS&H
DESIGNER Hutchins
DATE 11/11/91
CHECKER
DATE

Simplified Compressible Flow - Gas Pipe Line Formula from Crane p. 1-8 Eqn 1-7a

$$q_h' = 114.2 \sqrt{\frac{P_1'^2 - P_2'^2}{f L_m T S_g} d^5}$$

$$\left(\frac{q_h'}{114.2}\right)^2 = \frac{(P_1'^2 - P_2'^2)\, d^5}{f L_m T S_g}$$

$$d^5 = \frac{\left(\frac{q_h'}{114.2}\right)^2 f L_m T S_g}{P_1'^2 - P_2'^2}$$

- Find f

μ (viscosity, centipoise) = 0.011 p. A-5 Crane's

$$Re = 0.482 \frac{q_h' S_g}{d \mu}$$

f	d(")	Pipe Size	Re
0.015	6.065	6	4.3 E6
0.0141	7.981	8	3.3 E6
0.0139	10.02	10	2.6 E6

Solving for d for various ΔP's for

ΔP	d(")
10	9.3
20	8.2
30	7.7
40	7.4

q_h' = 870,000 cf/hr
f = 0.014
L_m = 1500 ft / 5280 f = 0.28 mi.
T = 520°R
S_g = 0.69
P_1' = 65 psia
P_2' = 25 − 55 psia

RS&H®

SUBJECT Nat. Gas Line

AEP NO

SHEET ______ OF ______

DESIGNER P. Hutchins

DATE 11/11/91

CHECKER

DATE

$$P_1'^2 - P_2'^2 = \frac{\left(\frac{q_h'}{114.2}\right)^2 f L_m \bar{T} S_g}{d^5}$$

$$P_2' = \sqrt{P_1'^2 - \frac{\left(\frac{q_h'}{114.2}\right)^2 f L_m \bar{T} S_g}{d^5}}$$

d (")	ΔP
6	750
8	23.2
10	7.6
12	3.6

← 8" is selection

CONSTRUCTION COST ESTIMATE							DATE PREPARED 11/11/91	SHEET OF
PROJECT: ENERGY ENGINEERING ANALYSIS							BASIS FOR ESTIMATE	
LOCATION: WATERVLIET ARSENAL - Albany, NY							☐ CODE A (No design completed) ☒ CODE B (Preliminary design) ☐ CODE C (Final design) ☐ OTHER (Specify)	
ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.								
DRAWING NO.		ESTIMATOR: P. Hutchins				CHECKED BY		

Natural Gas Line SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Steel pipe, SCH 40, 8"d.							
tar coated & wrapped	1500	LF	10.84	$16,260	26.00	$39,000	$55,260
Excavation - 16" x 5'	1500	LF	0.47'	705	—	—	705
Horizontal boring							
Railroad work 24"d.	360	LF	320.00'	115,200	40.00	14,400	129,600
Backfill, dozier							
compacting	300	CY	1.76'	528	—		528
Bedding, crushed							
stone	300	CY	4.28	1248	12.90	3870	5118
				133,941		57,270	191,211
Boiler Plant interconnect	1	ea	5000	5000	5000	5000	10,000
Metering Station	1	ea	5000	5000	5000	5000	10,000
				143,941		67,270	211,211

'Includes equipment costs

Ref: 1991 Means, Mechanical p. 18-22

ENG FORM 150
1 AUG 59

(ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—516148

02/05/92

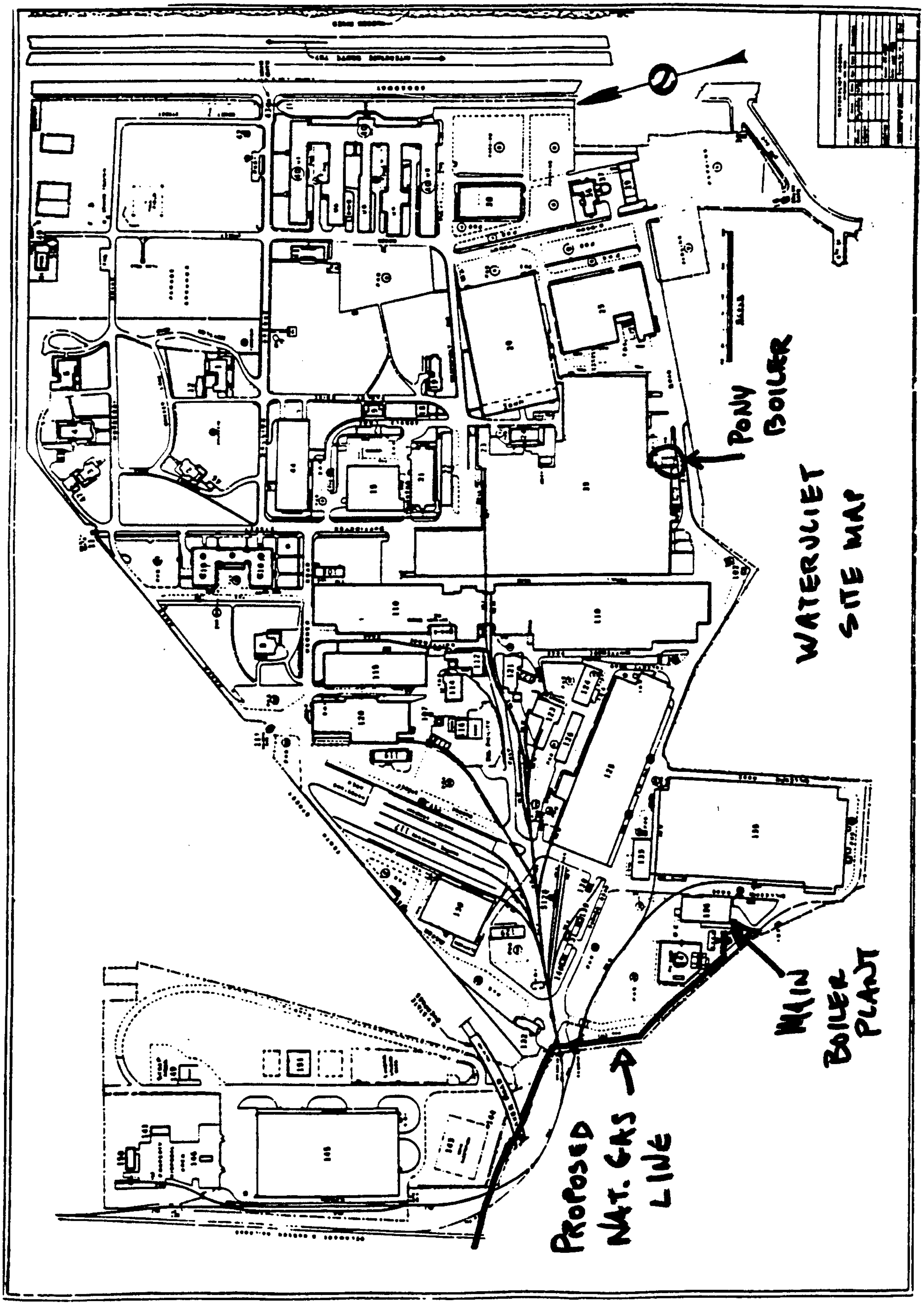
ECO Construction Cost Estimate
Calculations

ECO Name: NATURAL GAS FUEL SWITCH

ECO #: 2

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$67,270
Labor		$143,941
	Subtotal bare costs	$211,211
FICA Insurance (20% of Labor)		$28,788
Sales Tax (6.5% of Material)		$4,373
	Subtotal	$244,372
Overhead (15%)		$36,656
	Subtotal	$281,028
Profit (10%)		$28,103
	Subtotal	$309,131
Bond (1%)		$3,091
	Subtotal	$312,222
Contingency (10%)		$31,222
Subtotal (Construction Cost Input For LCCID *)		$343,444
SIOH (6% of Construction Cost)		$20,607
	Subtotal	$364,051
Design (6% of Construction Cost)		$20,607
Total Project Cost		$384,658

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.


WATERVLIET SITE MAP
PONY BOILER
MAIN BOILER PLANT
PROPOSED NAT. GAS LINE

RS&H

SUBJECT	ECO # 3 Cogeneration	AEP NO	290 0379-002
		SHEET	OF
DESIGNER	P. Hutchins	DATE	6/28/91
CHECKER	B. Todd	DATE	9/16/91

- Current fuel use - FY 90

	MBTU
ELC	173,000
FSD	12,000
FSR	278,000
NGAS	65,000

- Calculate energy savings

- Size and type of cogen equipment

Demand data from WVA (Figures 3-1 and 3-2) show a constant load of about 3 MW at all times, a 9 MW load 0800 - 1500 hrs Monday through Friday and about 5 MW for 1500-0800, M-F.

Steam use is shown on a monthly basis in Figure 3-3. It shows a minimum average steam production of 6000 #/hr during non-space heating periods (this represents metal plating heat loads in Bldg 35) and varying loads up to 65,000 #/hr dependent upon the weather for space heating.

Figure 3-4 shows the steam production during the summer by day of week. It demonstrates a 1000 #/hr load Monday through Thursday.

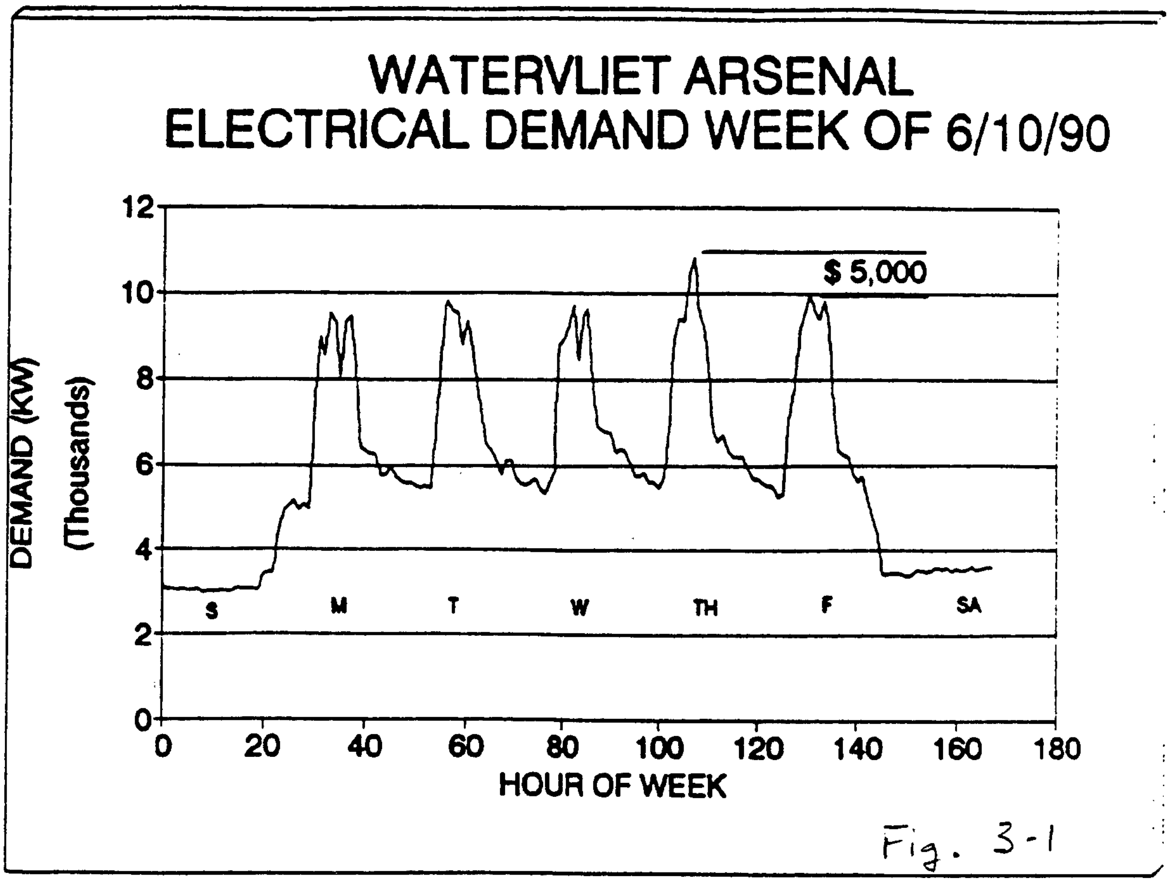

WATERVLIET ARSENAL
ELECTRICAL DEMAND WEEK OF 6/10/90
DEMAND (KW)
(Thousands)
HOUR OF WEEK
$ 5,000
S
M
T
W
TH
F
SA

Fig. 3-1

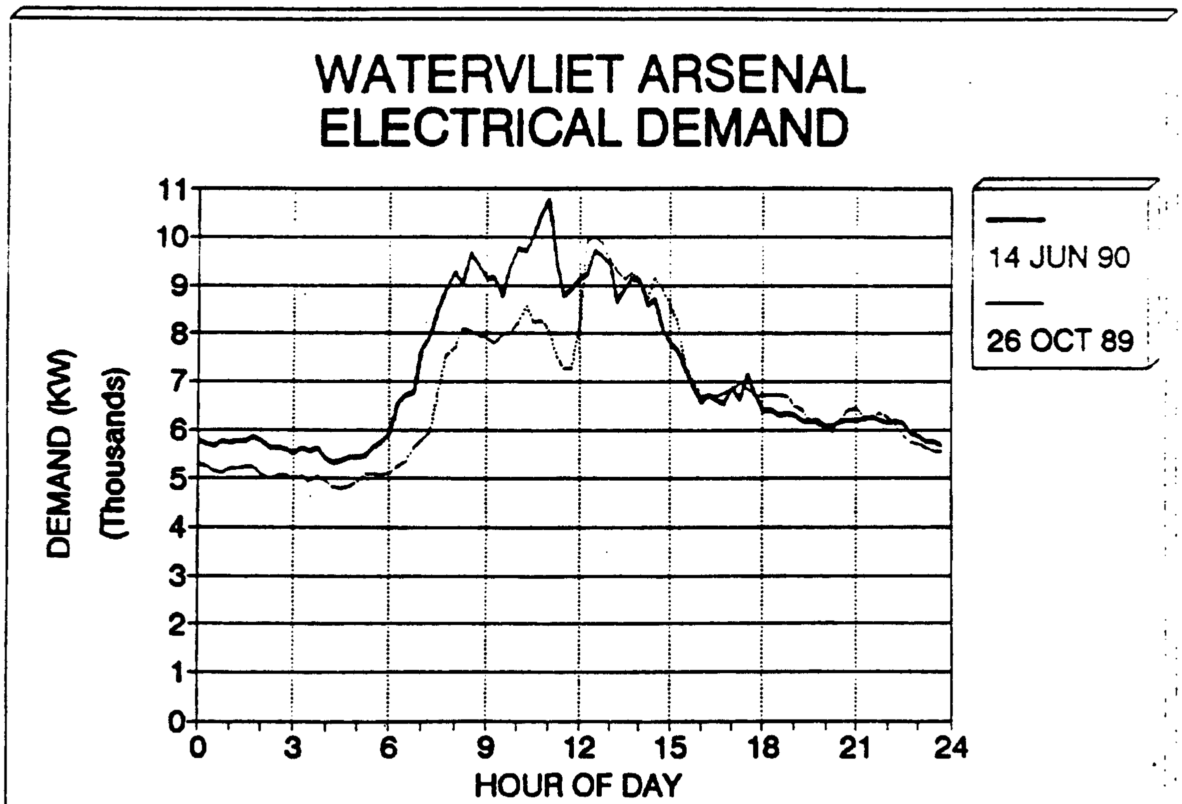

WATERVLIET ARSENAL
ELECTRICAL DEMAND
DEMAND (KW)
(Thousands)
HOUR OF DAY
14 JUN 90
26 OCT 89

Fig 3-2

RS&H®

SUBJECT ECO #3 - Cogeneration

AEP NO

SHEET ____ OF ____

DESIGNER P. Hutchins

DATE 7/8/91

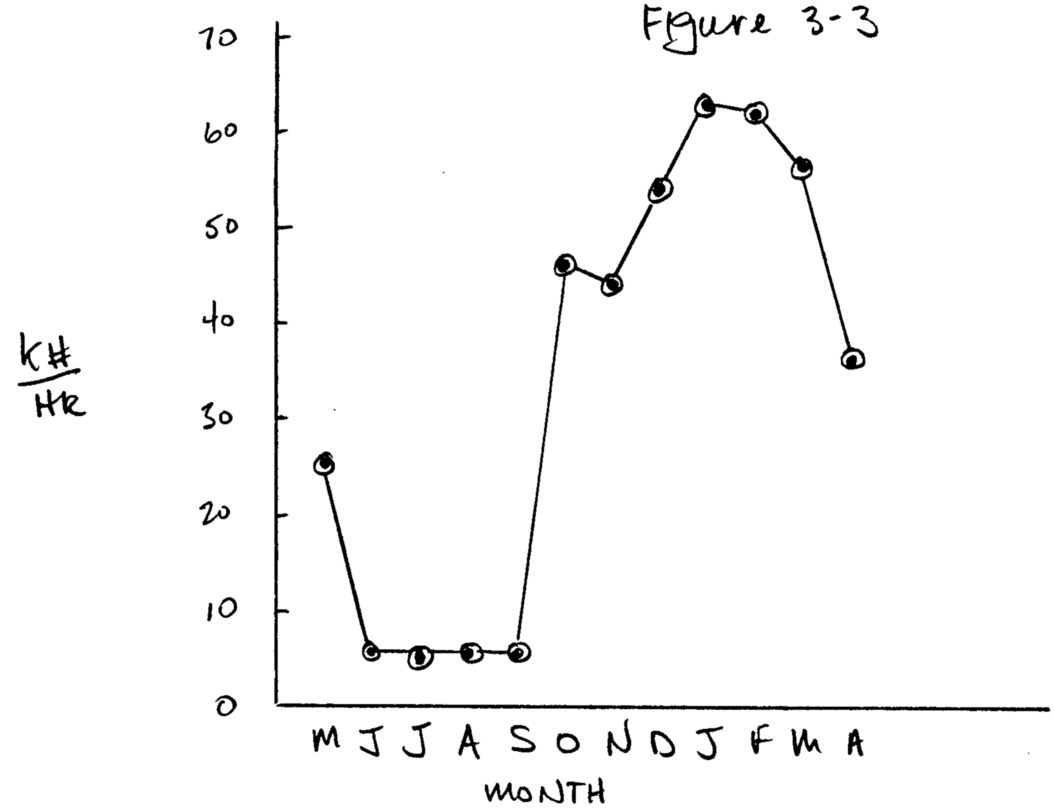
CHECKER

DATE

Monthly Steam Use - Bldg 136 + 35

		AUG DLY	HRLY
'90	M	612	25.5
	J	152	6.3
	J	135	5.6
	A	147	6.1
	S	142	5.9
	O	1142	47.6
	N	1059	44.1
	D	1295	54.0
'91	J	1502	62.6
	F	1492	62.2
	M	1250	52.1
	A	854	35.6

Figure 3-3



SUBJECT	ECO # 3 - Cogeneration
DESIGNER	P. Hutchins
CHECKER	

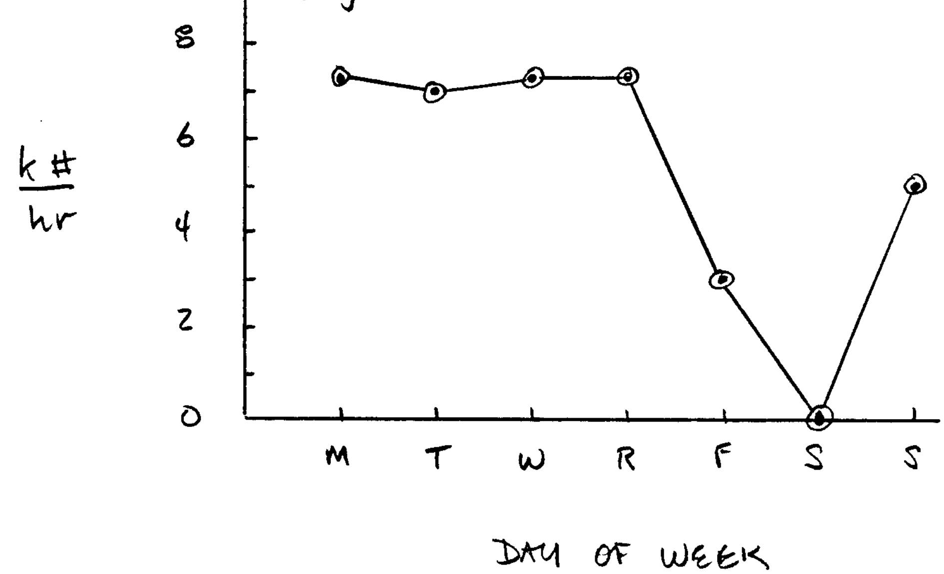
AEP NO	
SHEET	OF
DATE	7/8/91
DATE	

RS&H®

Building 35 Boiler Steam Production

	JUNE 4-10	JUNE 11-17	JUNE 18-24	AUG 6-12	AUG 13-19	AUG 20-26	AVG DLY	AVG HRL
M	224	179	167	140	161	176	175	7.3
T	205	169	169	140	117	206	168	7.0
W	194	169	171	157	164	188	174	7.3
R	156	190	189	167	167	160	172	7.3
F	41	86	71	53	76	98	71	3.0
S	-	-	-	-	-	-	0	0
S	75	92	140	109	107	191	119	5.0

FIG. 3-4 AVG. STEAM PRODUCTION



RS&H®

SUBJECT Cogen | AEP NO
SHEET ___ OF ___
DESIGNER ___ DATE 6/28/91
CHECKER ___ DATE ___

The ratio of the heat-to-electricity requirements determine which type of cogeneration equipment is preferred. This is shown in Figure 3-5. In general this figure shows the following preferences:

Heat/Electrical Output	Recommended Equipment
< 4	Reciprocating Engine
$> 4, < 10$	Gas Turbine
> 10	Steam Turbine

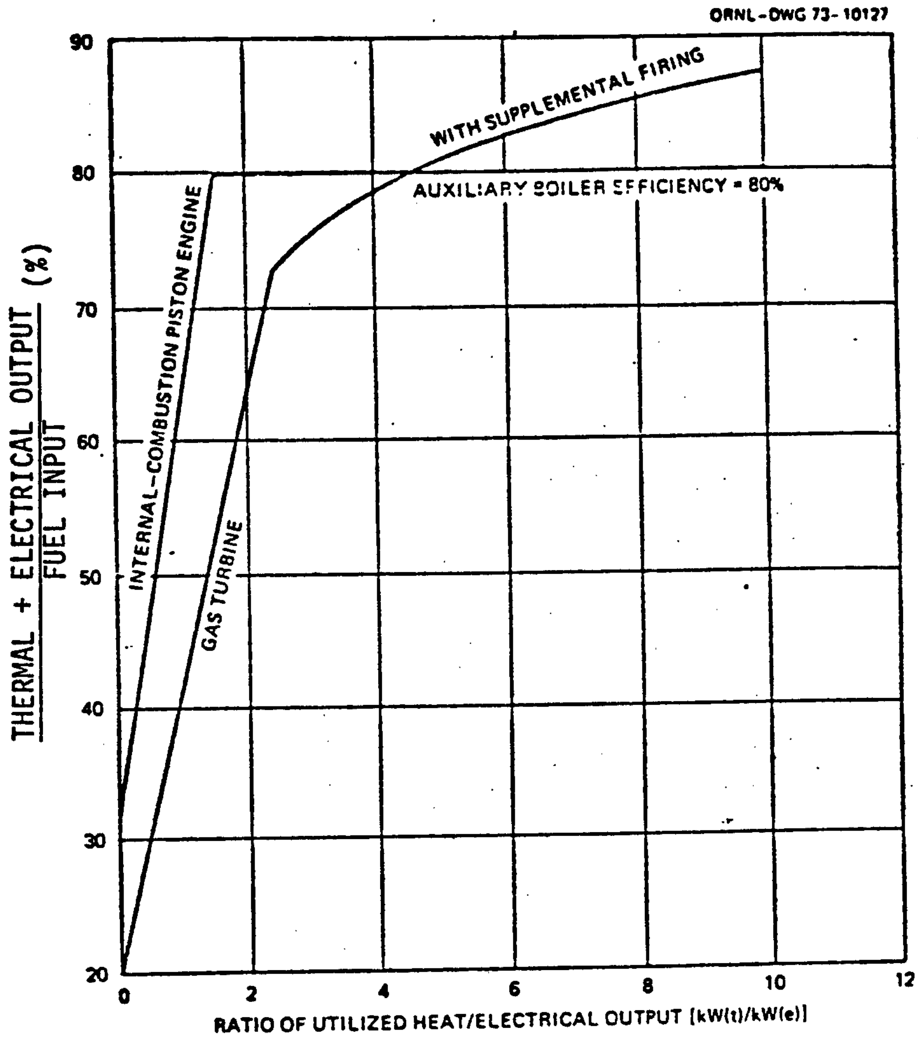
To obtain maximum utilization of the cogen equipment and, therefore, maximum benefit calculate H/E based on 3 MW and 1000#/hr.

$$\frac{H}{E} = \frac{3\,000 \text{ kw}}{7000\#/\text{hr}} \cdot \frac{3413 \text{ Btuh/kw}}{1000 \text{ Btu}/\#} = \underline{1.46}$$

This indicates that a reciprocating engine is the best match. The exception to this is a steam-injected gas turbine that utilizes some or all of the steam produced to power a steam turbine mounted on the gas turbine shaft. This system will also be evaluated.

FIG. 3-5

PRIME MOVER PERFORMANCE COMPARISON



REF: TECHNOLOGY ASSESSMENT OF
MODULAR INTEGRATED UTILITY SYSTEMS,
OAK RIDGE NAT'L LAB

RS&H

SUBJECT ECO#3

AEP NO

SHEET ____ OF ____

DESIGNER

DATE

CHECKER

DATE

- Calculate reciprocating engine energy use

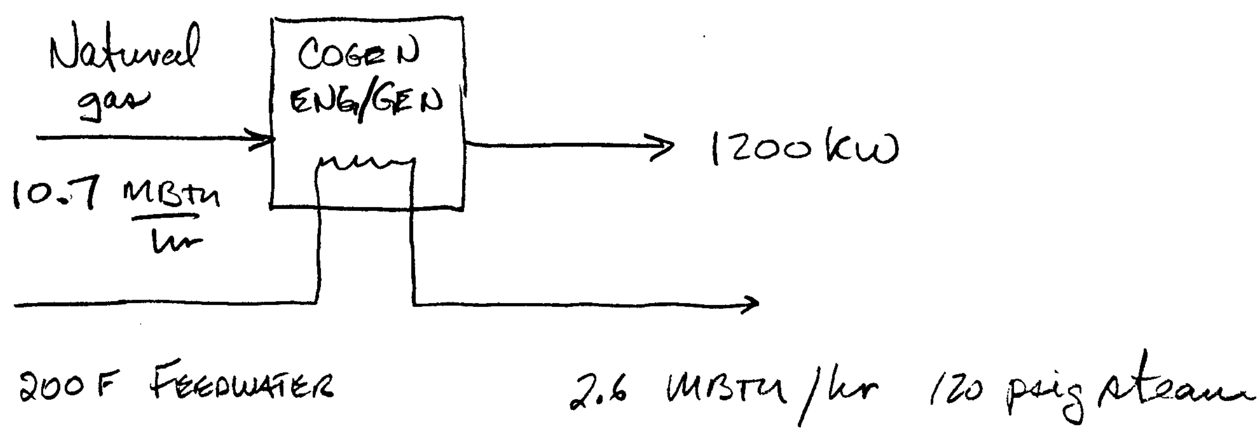
Assumptions:

Steam req'ment - ~7000 #/hr 150 psig

Elec. req'ment - none, NIMO must buy all cogenerated

Because of the 150 psig requirement, heat cannot be recovered from the engine jacket cooling water. The engine exhaust gas is the only source.

Using the Caterpiller Model 3608 with Vapor phase heat recovery silencers and economizers:



To maximize the use of the cogeneration unit, two engines should be used.

RS&H®

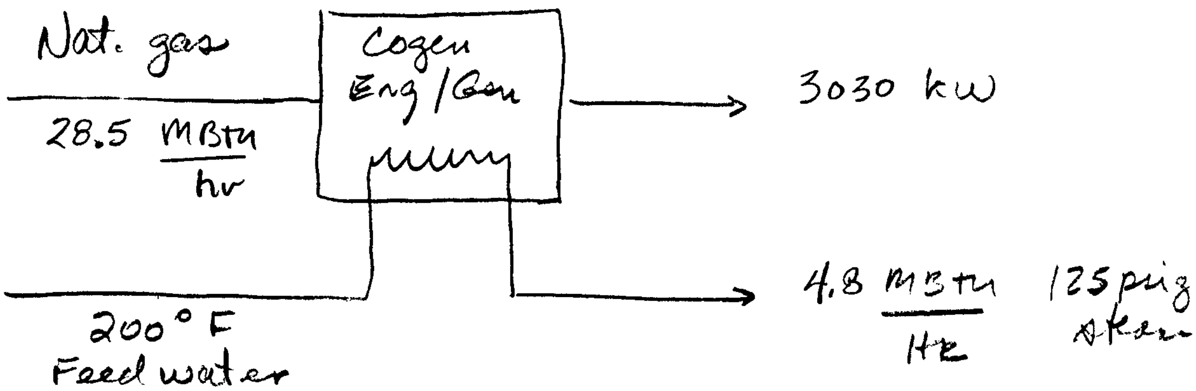
SUBJECT ECO #3 AEP NO ____

SHEET ____ OF ____

DESIGNER ____ DATE ____

CHECKER ____ DATE ____

The overall performance for two MODEL 3608 engine/generators (based on data ~~located~~ on pages 3-11:3-13) is:



Annual energy use: $50 \frac{wks}{yr} \cdot 5 \frac{da}{wk} \cdot 24 \frac{hr}{da} = 6000 \frac{hrs}{yr}$

Nat. Gas: $28.5 \frac{MBtu}{hr} \cdot 6000 \frac{hrs}{yr} = 171{,}000 \frac{MBtu}{yr}$

Annual energy savings:

Nat. Gas: $4.8 \frac{MBtu}{hr} \cdot 6000 \frac{hr}{yr} \cdot \frac{4}{12}$ of yr (summer)

$\div$ 0.77 Blr eff (p. I-12 App B) $= 12{,}500 \frac{MBtu}{yr}$

Fuel Oil: 4.8 MBtu/hr $\cdot 6000 \cdot \frac{8}{12} \div 0.83$ (p. I-12 App B) $= 23{,}100 \frac{MBtu}{yr}$

Annual dollar savings due to electricity purchase by NIMO @ 6¢/kwh:

$3030 \text{ kW} \cdot 6000 \frac{hrs}{yr} \cdot \frac{\$0.06}{kwh} = \frac{\$1{,}090{,}800}{yr}$

RS&H	SUBJECT ECO #3	AEP NO	
		SHEET	OF
	DESIGNER	DATE	
	CHECKER	DATE	

Other annual cost

Maintenance ≈ 1.5¢/kwh

$$\frac{\$0.015}{kwh} \cdot 3030\,kw \cdot 6000\,\frac{hrs}{yr} = \frac{\$273,000}{yr}$$

Summary of energy use changes for total installation

	Annual Use (MBtu) Current	w/ Cogen	savings
ELC	173,000	173,000	0
FSR	278,000	254,900	23,100
NGAS	65,000	223,500	(158,500)

Annual dollar savings due to sales of electricity to NIMO =

$1,090,800/yr.

Estimated payback = 10.5 yrs

$$\frac{\$800/kw * 3030\,kw}{\$1,090,800 - 273,000 + 23,100 * \frac{\$6.61}{MBtu} - 158,500 * \frac{\$4.66}{MBtu}}$$

CONSTRUCTION COST ESTIMATE	DATE PREPARED 8/6/91	SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WATERVLIET ARSENAL

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.:

ESTIMATOR: Paul Hutchins

CHECKED BY:

ECO#3-Cogen. SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
CATERPILLAR SPARK-Ignited Engine Generators Model 3608-1515kW	2	EA			875k	1,750,000	1,750,000
(includes switchgear, utility breaker, main breaker)							
Exhaust heat recovery system and valving	2	EA			77.5k	155,000	155,000
Economizers	2	EA			27.5k	55,000	55,000
Substation switchgear					100K	100,000	100,000
INSTALLATION COSTS (@ $250/kW)				850,000			850,000
TOTALS				850,000		2,060,000	2,910,000

ENG FORM 150, 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—516148

RS&H

Telephone Call Confirmation

(904) 737-7730

Project No. 290-0379-002

Local ______ L.D. ✓ Placed ✓ Rec'd. ✓ Date 7/10/91

P. HUTCHINS Conversed With DAVID WOOD

Of CATERPILLAR - RINGPOWER Regarding Cogen - WVA

Three alternatives:	output (125 psia)	MATERIAL COST
- One Model 3616	- 3MW ~ 5000 #/hr	$2.25 mill.
- Two Model 3608	- 3MW ~ 5000 #/hr	1.75 mill.
- Four Model 3516	- 3.2MW ~ 4800 #/hr	1.5 mill.

O & M cost - 1.5¢/KWh

Installation cost - $200 - $300 / kW

Includes: Engine, switchgear, utility breaker, main breaker

If I change the steam ~~pressure~~ how does that affect output

DW is ~~x~~ faxing performance sheets

Soutworth ~~Machinery~~ Milton (518) 465-5255
Cat. Dealer in New York

Distribution:

3/89

CATERPILLAR, INC.
SPARK IGNITED ENGINE DIVISION

3608 SI
PERFORMANCE DATA

		Heat Exch Cooled	Radiator Cooled
ENGINE POWER			
Electric Kilowatts	Ekw	1515	1430
Brake Horsepower	Bhp	2120	2000
BMEP	Psi	180	170
Speed	Rpm	900	900
FUEL CONSUMPTION			
BSFC	Btu/Bhp-Hr	6715	6715
Thermal Efficiency	%	37.9	37.9
EMISSIONS			
BSNOx	G/Bhp-Hr	1.0	1.0
BSCO	G/Bhp-Hr	1.7	1.7
BSTHC	G/Bhp-Hr	5.0	5.0
BSNMHC	G/Bhp-Hr	0.6	0.6
FUEL TOLERANCE			
Fuel Range, LHV	Btu/CuFt	900-1200	900-1200
Methane Number Range		50-100	50-100
GENERAL			
AC/OC Water Temp	Deg F	90	130
Jacket Water Temp	Deg F	185	185
Air/Fuel Ratio	Vol/Vol	20	20
Timing	Deg BTDC	20	20
Air Flow	Lb/Hr	24050	22750
Exhaust Flow	Acfm	13250	12550
Stack Temp	Deg F	800	800
GENERATOR			
Stability	ISO Class	II	II
Response	ISO Class	II	II

NOTES

1. Ratings are based on SAE J1349 standard ambient conditons of 29.61 in Hg and 77 deg F. Variations in altitude, temperature and gas composition may require engine rating and performance adjustment. For these special applications, consult your Caterpillar Power Systems Distributor.

2. Electrical rating based on 0.8 power factor and 95.5% generator efficiency.

VAPORPHASE
ENGINEERING CONTROLS, INC.

July 12, 1991

Ring Power Company
8050 Phillips Highway
Jacksonville, FL 32216

Attn: Mr. David Wood

Subject: RS & H
Our Proposal #7286

Dear Dave:

We offer the following equipment for (4) G-3516SITA-90 gas engines at 800 KW and 1200 RPM or for (2) G-3608SITA-90 gas engines at 1515 KW and 900 RPM.

<u>(4) Caterpillar G-3516SITA-90 Rated 800 KW at 1200 RPM</u>

(4) Model ECXSV-4410 Bare fire tube exhaust only waste heat recovery silencers, ASME Code stamped for 150 PSIG to produce 125 PSIG steam with full steam trim, insulated.
Anticipated recovery at full load, clean per engine: 1,025,994 BTU/HR or 974 #/HR of 125 PSIG steam with 200 Deg. F feed water.
Unit weight: 7,843#

(4) Model EDVP-14 Pneumatic internal exhaust diversion valves with pilots.
Unit weight: 145#

(1) Model BPB-2 Pneumatic back pressure valve and pilot.
Unit weight: 110#

<u>(2) Caterpillar G-3608SITA-90 Rated 1515 KW at 900 RPM</u>

(2) Model ECXSV-5410 Bare fire tube exhaust only waste heat recovery silencers, ASME Code stamped for 150 PSIG to produce 125 PSIG steam with full steam trim, insulated.
Anticipated recovery at full load, clean per engine: 2,393,243 BTU/HR or 2,272#/HR of 125 PSIG steam with 200 Deg. F feed water.
Unit weight: 10,316#

600 SOUTH HOLMES
TLX. 43-4230
SAINT LOUIS, MISSOURI 63122-6571
314-821-7900
FAX 314-821-2275

Engineering Controls

Ring Power Company
July 12, 1991
Page #2. . .

(2) Model EDVP-20 Pneumatic internal exhaust diversion valves with pilots.
Unit weight: 175#

(1) Model BPB-2 Pneumatic back pressure valve and pilot.
Unit weight: 110#

Should an economizer be added to either unit, performance would be improved by 10%.

The cost for the economizer on the ECXSV-4410 would be Each per unit.

The cost for the economizer on the ECXSV-5410 would be Each per unit.

Delivery is 14-16 weeks after receipt of approved submittal package.

We trust this gives you the information you require for now. Please feel free to contact us if we can be of any further assistance.

Very truly yours,

Peter Enslin

PCE/rb

Enclosure

Pricing - 4, 3516's $240,000
2, 3608's 155,000

Economizer - 4, 3516's 65,000
- 2, 3608's 55,000

RS&H®

SUBJECT ECO #3
Gas Turbine Option

DESIGNER

CHECKER

AEP NO

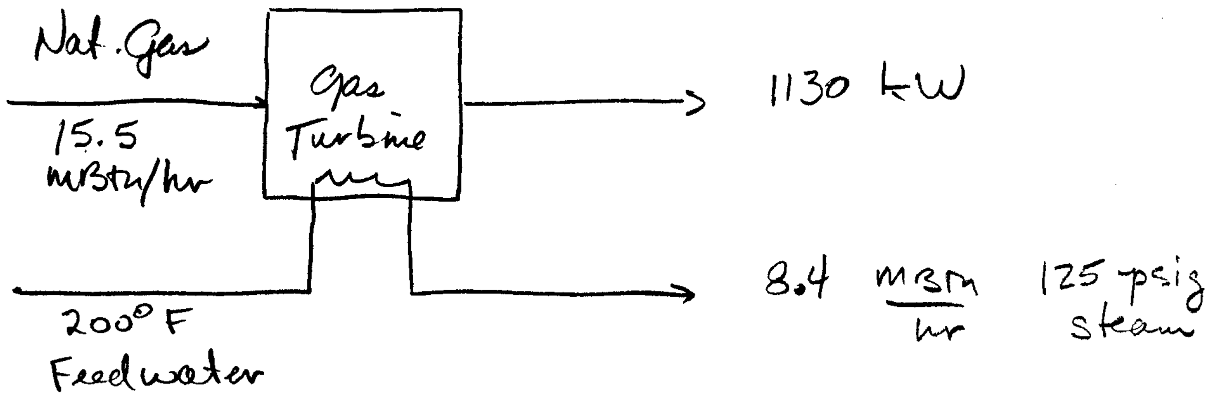
SHEET OF

DATE

DATE

- Calculate gas turbine energy use

The block diagram below demonstrates the gas turbine engine/generator performance for the SOLAR T 1500 (1130 kw) turbine (based on data located on p. 3-18 : 3-19)



<u>Annual energy use</u>

Nat Gas: 15.5 MBtu/hr * 6000 hrs = 93,000 MBtu/yr

Annual energy savings:

Nat. Gas: $5.9 \frac{MBtu}{hr} \cdot 6000 \frac{hrs}{yr} \cdot \frac{4}{12} \div 0.77 =$ 15,300 $\frac{MBtu}{yr}$

Fuel Oil: $5.9 \frac{MBtu}{hr} \cdot 6000 \frac{hrs}{yr} \cdot \frac{8}{12} \div 0.83 =$ 28,400 $\frac{MBtu}{yr}$

<u>Annual Electricity sales</u>

$1130 kW \cdot 6000 \frac{hrs}{yr} \cdot \frac{\$0.06}{kWh} =$ \$406,800/yr.

RS&H

SUBJECT ECO #3 - Gas Turbine Option
DESIGNER P. Hutchins
CHECKER
AEP NO
SHEET OF
DATE
DATE

Annual maintenance costs ≃ 1.0¢/kwh

$$\frac{\$0.01}{\text{kwh}} \times 1130\ \text{kw} \times \frac{6000\ \text{hrs}}{\text{yr}} = \$68{,}000/\text{yr.}$$

Summary of energy use changes for total installation

Annual Use (MBtu)

	CURRENT	w/ COGEN	SAVINGS
ELC	173,000	173,000	0
FSR	278,000	249,600	28,400
NGAS	65,000	142,700	(77,700)

Annual dollar savings due to electricity sales

= $406,800

Estimated payback = initial cost ÷ annual savings

$$\frac{1130\ \text{kw} \times 1200\ \$/\text{kw}}{\$406{,}800 - \$68{,}000 + 28{,}400\ \text{MBtu} \times \frac{\$6.61}{\text{MBtu}} - 77{,}700\ \text{MBtu} \times \frac{\$4.66}{\text{MBtu}}}$$

≃ 8.3 years

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: COGENERATION

ECO #: 3

1991 ECO "bare" costs		
Material		$672,927
Labor		$168,232
	Subtotal bare costs	$841,159
FICA Insurance (20% of Labor)		$33,646
Sales Tax (not applicable for GOGO)		$0
	Subtotal	$874,805
Overhead (15%)		$131,221
	Subtotal	$1,006,026
Profit (10%)		$100,603
	Subtotal	$1,106,629
Bond (1%)		$11,066
	Subtotal	$1,117,695
Contingency (10%)		$111,770
Subtotal (Construction Cost Input For LCCID *)		$1,229,464
SIOH (6% of Construction Cost)		$73,768
	Subtotal	$1,303,232
Design (6% of Construction Cost)		$73,768
Total Project Cost		$1,377,000

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED 8/14/91

SHEET OF

PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
WATERVLIET ARSENAL

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS [redacted]., INC.

BASIS FOR ESTIMATE
- [X] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. ECO#3- Cogen Gas Turbine

ESTIMATOR P. Hutchins

CHECKED BY

SUMMARY	QUANTITY: NO. UNITS	QUANTITY: UNIT MEAS.	LABOR: PER UNIT	LABOR: TOTAL	MATERIAL: PER UNIT	MATERIAL: TOTAL	TOTAL COST
Solar Gas Turbine							
Saturn T1500-1120kw	1	ea			750K	750,000	750,000
(includes generator							
and controls)							
Exhaust heat recovery	1	ea			247K	247,000	247,000
system							
Substation switchgear					100K	100,000	100,000
Installation costs				280,000			280,000
(@ $250/kw)							
TOTALS				280,000		1,097,000	1,377,000
INCLUDES ALL							
MARKUPS							

ENG FORM 150
1 AUG 59

(ER 1110-345-730)

PREVIOUS EDITION MAY BE USED

(TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—516148

RS&H

Telephone Call Confirmation

(904) 737-7730

Project No. 290-0379-002

Local ✓ L.D. ______ Placed ✓ Rec'd. ______ Date 8/7/91

P. Hutchins Conversed With Roger Adkins

Of Caterpillar Regarding Solar Turbines

- Noel Schoonmaker is the POC for Solar Turbines
- Solar Turbine Joe St. Pierre
- Price & performance data

Saturn 1130 kW T-1500 New rating

~~43~~ 13,764 Btu/kWh

904°F exhaust

$750,000 materials engine, generator & controls

Distribution:

VAPORPHASE
ENGINEERING CONTROLS, INC.

August 14, 1991

Reynolds, Smith & Hill
4651 Salisbury Road
Jacksonville, FL 32256

Attn: Mr. Paul Hutchins

Subject: Our Budget Proposal #7319

Dear Paul:

We offer the following equipment for (1) Solar T-1500 Gas Turbine rated 1120 KW.

(1) Model ECXWTSE-4000-750 2-drum, natural circulation, high fin exhaust only waste heat recovery silencer with insulation and full steam trim per Drawing B-P-2481, Rev. 0.
Unit includes the following:
(1) Economizer
(2) Stack
(3) Exhaust Diversion Valve
(4) Exhaust Diversion Valve Silencer
(5) Flexible Connections
(6) Duct and Platform
Approximate size: 7'-0" wide x 3'-6" high x 28'-0" long.
Anticipated recovery of 125 PSIG steam with 220 Deg. F feed water: 8,000 #/HR.
Unit weight: 25,000# Budget Price: $247,100.00 Each

FOB St. Louis, MO. Terms are Net 30 Days. Progress payments would be required.
Delivery is 16 weeks after receipt of approved submittal package.

We trust this gives you the information you require for now. Please feel free to contact us if we can be of any further assistance.

Very truly yours,

Peter C. Enslin

PCE/rb

Enclosures

600 SOUTH HOLMES SAINT LOUIS, MISSOURI 63122-6571 314-821-7900
TLX. 43-4230 FAX 314-821-2275

ECO#4 Dip Tank Covers with Exhaust Fan Controllers

Assumptions:

- Room Temperature = 68°F
- Heat Load Factor (HLF) (Vol. II, App B. p I-8 thru I-10)

HLF_1 = 0.145 MBtu/yr/cfm (24h/d, 5d/w)
HLF_2 = 0.092 MBtu/yr/cfm (16h/d, 5d/w)
HLF_3 = 0.044 MBtu/yr/cfm (8h/d, 5d/w)
HLF_4 = 0.204 MBtu/yr/cfm (24h/d, 7d/w)

- Fan and motor efficiency = 0.5
- Steam Generation Efficiency Avg. = 0.80 (ECO#6)
- Fan ΔP = 3 in. w.c.
- Leakage with cover in place - 10% of uncovered

- Calculate present energy use - fuel oil for heating OSA replacing exhausted air and electricity used by fan motors

Fuel Oil

$$E_{OSA} = \frac{CFM * 0.204\ MBtu/yr/cfm}{\text{Steam Gen. eff}}$$

$$hp = \frac{cfm \cdot \Delta P}{6356\ \eta_{fan}} \Rightarrow cfm = 0.75\frac{hp * 6356 * \eta_{fan}}{\Delta P}$$

- Calculate current fan energy use

Elec

$$E_{fan} = hp * \overset{2545}{Btu/hp} * 8760\ hr/yr * \frac{1\ MBtu}{10^6\ Btu} * 0.75$$

$$\text{where } hp = \frac{cfm \cdot \Delta p}{6356 \cdot \eta_{fan}}$$

Assume fan/motor operate at 75% of rated hp

SUBJECT	ECO # 4	AEP NO	
		SHEET	OF
DESIGNER		DATE	
CHECKER		DATE	

- Calculate energy use with tank covers and VSDs

Plating operations are active for 1, 2 or 3 shifts five days per week

# shifts	Hours/yr covered	Hours/yr uncovered
1	6240	2520
2	4600	4160
3	2080	6680

With covers in place it is estimated that the cfm will be reduced to 10% of the original flow

Fuel Oil

$$\text{Energy Use} = \frac{CFM_c * HLF_c}{0.80} + \frac{CFM_{uc} * HLF_{uc}}{0.80}$$

where the subscript c and uc represent covered and uncovered events

$$CFM_c = CFM_{uc} \div 10 \qquad CFM_{uc} = \frac{hp * 6356 * \eta_{fan}}{\Delta P}$$

$$HLF_{uc} = HLF_4 - HLF_{\#SHIFTS}$$

Elec

hp varies with the cube of the flow

$$\frac{hp_2}{hp_1} = \left(\frac{cfm_2}{cfm_1}\right)^3 \qquad \frac{hp_2}{hp_1} = \left(\frac{cfm_1 * 0.10}{cfm_1}\right)^3 = 0.001$$

Therefore, if the flow is reduced to 10% of original the hp is reduced to 0.001 times the original hp.

SUBJECT ECO #4

AEP NO

SHEET OF

DESIGNER

DATE

CHECKER

DATE

Energy use = $hp_c * 2545 * 0.75 * H_c +$

$hp_{uc} * 2545 * 0.75 * H_{uc}$

where H = hours
c = covered
uc = uncovered
$hp_{uc} = hp_c * 0.001$
0.75 = fraction of rated hp for actual operation

- Savings equal the difference between the present energy use and use with proposed covers & VSDs

The following spreadsheet implements these equations.

Small Parts Plating Exhaust Fans

	Exhaust Fan ID	hp	Est. CFM	Supply Fan ID	hp	Tanks Served (IDs)	Type *
Line 1	103	60	47,670	?	?	3,7,8,9,11,15,16,21,22,23,24	PP
	106	10 **	7,945	103	10	14	PP
	107	10 **	7,945	103	10	19	PP
	104	40 **	31,780	103	10	28,29,30	PP
	105	60	47,670	103	10	31,32,33	BL
Line 2	101	25	19,863	101	1.5	3,5,13,16	PP
	102	40	31,780	102	2	19,20,21,30,31	PP
Line 3	108	60 **	47,670	104	?	2,3,4,5,6,7,8,9,10,11,12,13,14	PP
	109	40 **	31,780	-	-	19,20,25,26	BL
Line 4	110	15 **	11,918	-	-	4,5	BL
	111	40 **	31,780	-	-	6,7,8,9,11	BL
	112	10	7,945	-	-	10	BL

*Exhaust system
PP = push-pull
BL = bilateral pull only
**Estimated

	Exhaust Fan ID	# Shifts	# Tanks	Present Use(MBtu/yr) #6 F.O.	N Gas	Elec	Proposed Use (MBtu/yr #6 F.O.	N Gas	Elec	Savings (MBtu/yr) #6 F.O.	N Gas	Elec
Line 1	103	3	11	12,156	0	1,003	8,987	0	767	3,168	0	236
	106	3	1	2,026	0	167	1,498	0	128	528	0	39
	107	3	1	2,026	0	167	1,498	0	128	528	0	39
	104	3	3	8,104	0	669	5,992	0	512	2,112	0	157
	105	3	3	12,156	0	1,003	8,987	0	767	3,168	0	236
Line 2	101	2	4	5,065	0	418	3,745	0	201	1,320	0	217
	102	2	5	8,104	0	669	5,992	0	321	2,112	0	348
Line 3	108	1	13	12,156	0	1,003	8,987	0	296	3,168	0	707
	109	1	4	8,104	0	669	5,992	0	197	2,112	0	472
Line 4	110	3	2	3,039	0	251	2,247	0	192	792	0	59
	111	3	5	8,104	0	669	5,992	0	512	2,112	0	157
	112	3	1	2,026	0	167	1,498	0	128	528	0	39
Totals			53	83,065	0	6,855	61,415	0	4,148	21,650	0	2,707

Additional O&M :

Covers should be replaced every five years. On an annual basis assume 1/5 th are replaced every year

Annual cost = 1/5 $800 * 53 = $8480/yr

QRIP/OSD PIF CALC'S

Present Cost of Energy

Fuel oil	=	83,065	*	4.40	=	$ 365,486
Elec.	=	6855	*	20.35	=	139,499
TOTAL						$ 504,985

Proposed

Fuel Oil	=	61,415	*	4.40	=	$ 270,226
Elec	=	4148	*	20.35	=	84,412
Total	=					$ 354,638

Savings

Fuel Oil	=	21,650	*	4.40	=	$ 95,260
Elec	=	2707	*	20.35	=	55,087
Total	=					$ 150,347

CONSTRUCTION COST ESTIMATE	DATE PREPARED 8/21/91	SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WATERVLIET ARSENAL

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR: P. Hutchins

CHECKED BY

SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
ECO#4 Dip Tank Covers + Exhaust Fan Controllers							
Dip Tank Cover w MOVEABLE MOUNT	1	EA	300	300	500	500	800
FAN AP							
TRANSDUCER	1	EA	100	100	400	400	500
CONTROLLER			100	100	550	550	650
FAN MOTOR VARIABLE SPEED DRIVE	1	EA	300	300	2800	2800	3100
TOTALS				800		4250	5050

ENG FORM 150 1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

CONSTRUCTION COST ESTIMATE

DATE PREPARED 8/21/91

SHEET OF

PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
WATERULIET ARSENAL

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

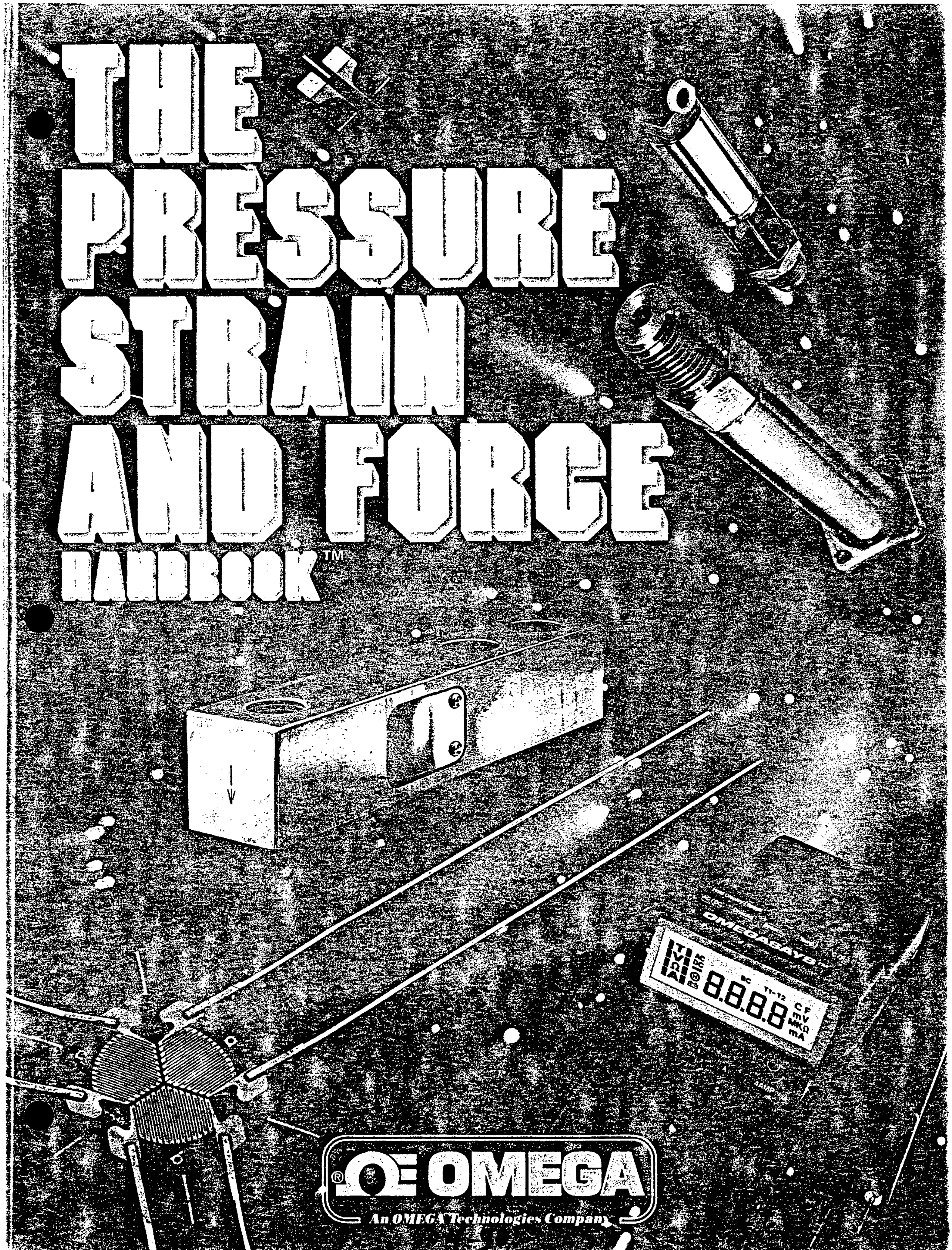
DRAWING NO.

ESTIMATOR P. HUTCHINS

CHECKED BY

ECO#4 - SUMMARY	QUANTITY: NO. UNITS	QUANTITY: UNIT MEAS.	LABOR: PER UNIT	LABOR: TOTAL	MATERIAL: PER UNIT	MATERIAL: TOTAL	TOTAL COST
Dip Tank Covers	53	ea	300	15,900	500	26,500	42,400
w/ moveable mount							
Fan ΔP							
TRANSDUCER	12	ea	100	1200	400	4800	6000.
CONTROLLER	12	ea	100	1200	550	6600	7800
FAN MOTOR Variable Speed Drive							
10 Hp	3	ea	300	900	3200	9600	10,500
15 Hp	1	ea	300	300	4000	4000	4300
25 Hp	1	ea	300	300	5000	5000	5300
40 Hp	4	ea	300	1200	6400	25,600	26,800
60 Hp	3	ea	300	900	9200	27,600	28,500
TOTALS				21,900		109,700	131,600

ENG FORM 1 AUG 59 150 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)


THE PRESSURE STRAIN AND FORCE HANDBOOK™
OMEGAGAGE
8.8.8.8
OMEGA®
An OMEGA Technologies Company

LOW PRESSURE DIFFERENTIAL TRANSDUCERS

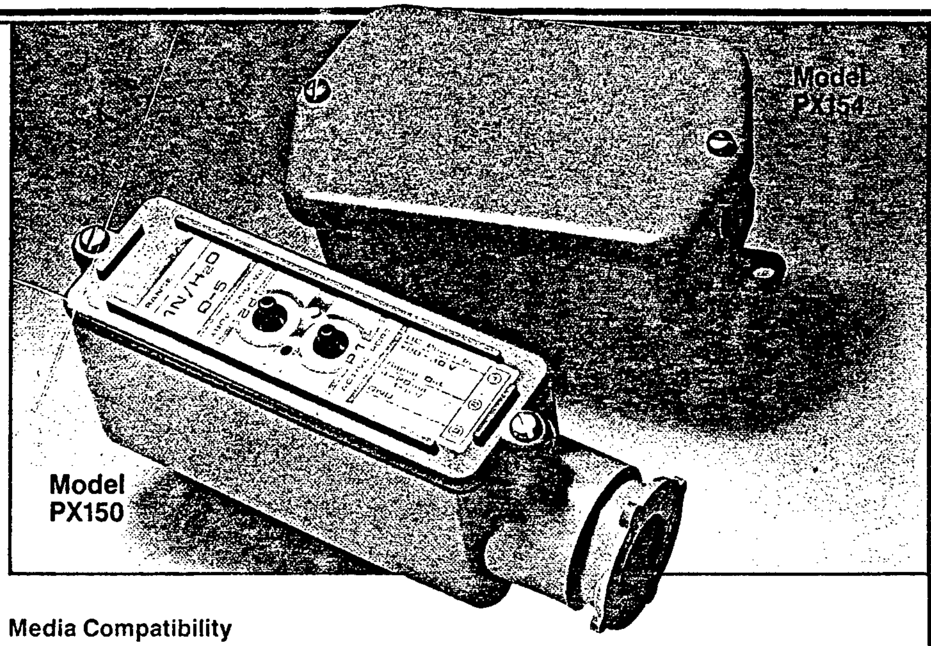
PX150/154 Series 0-1″ to 0-25″ H_2O

MADE IN USA

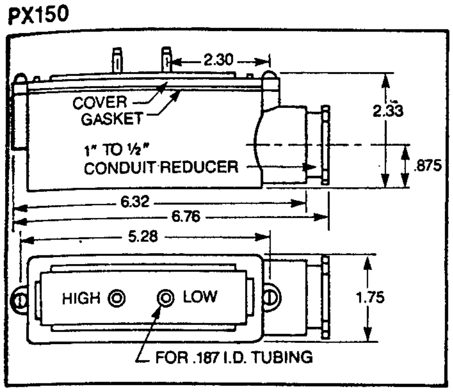
- Weatherproof NEMA-4 Enclosure or Electrical Conduit Enclosure
- Zero and Span Controls Are Provided For Easy Field Adjustment

From

$305



PX150



Media Compatibility

PX150

Low: Dry gases only

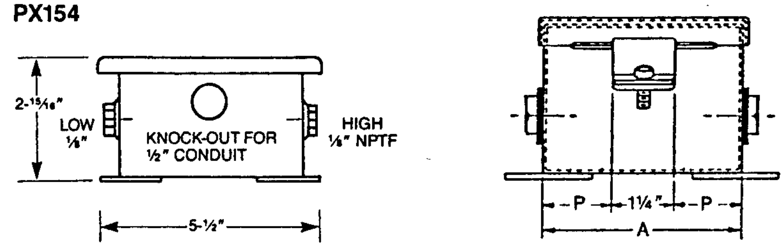
High: Liquids or gases, except highly ionic solutions (acids, lye, etc.)

PX154

P1 P2: Non-corrosive, non-aqueous liquids or gases

PX155 : SLIGHTLY CORROSIVE LIQUIDS OR GASES

PX154



SPECIFICATIONS

Excitation: 24 Vdc (18 to 30 Vdc)

Output: 4 to 20 mA, 2 wire system

Maximum Loop Resistance: 400 ohms @ 18 Vdc, 700 ohms @ 24 Vdc, 1000 ohms @ 30 Vdc

Accuracy: (linearity & hysteresis) PX154 0.1% FS; PX150 2.0% FS

Zero and Span Adjustments: ±10%

Compensated Temperature Range: 32 to 122°F (0 to 50°C)

Zero and Span Thermal Effects: PX154 (.311/FS range) % FS/°F; PX150 (3.9/FS range) % FS/°F

Proof Pressure: PX150 3 PSI; PX154 15 PSI

Burst Pressure: PX150 5 PSI; PX154 20 PSI

Gages: Solid state piezoresistive

Cover Material: PX150 PVC-1″ electrical access enclosure; PX154 NEMA-4 gasketed steel enclosure with enamel finish

Pressure Port: PX150 0.187″ diameter tube fitting ports; PX154 ⅛″ NPT female

Electrical Connection: Internal screw terminations

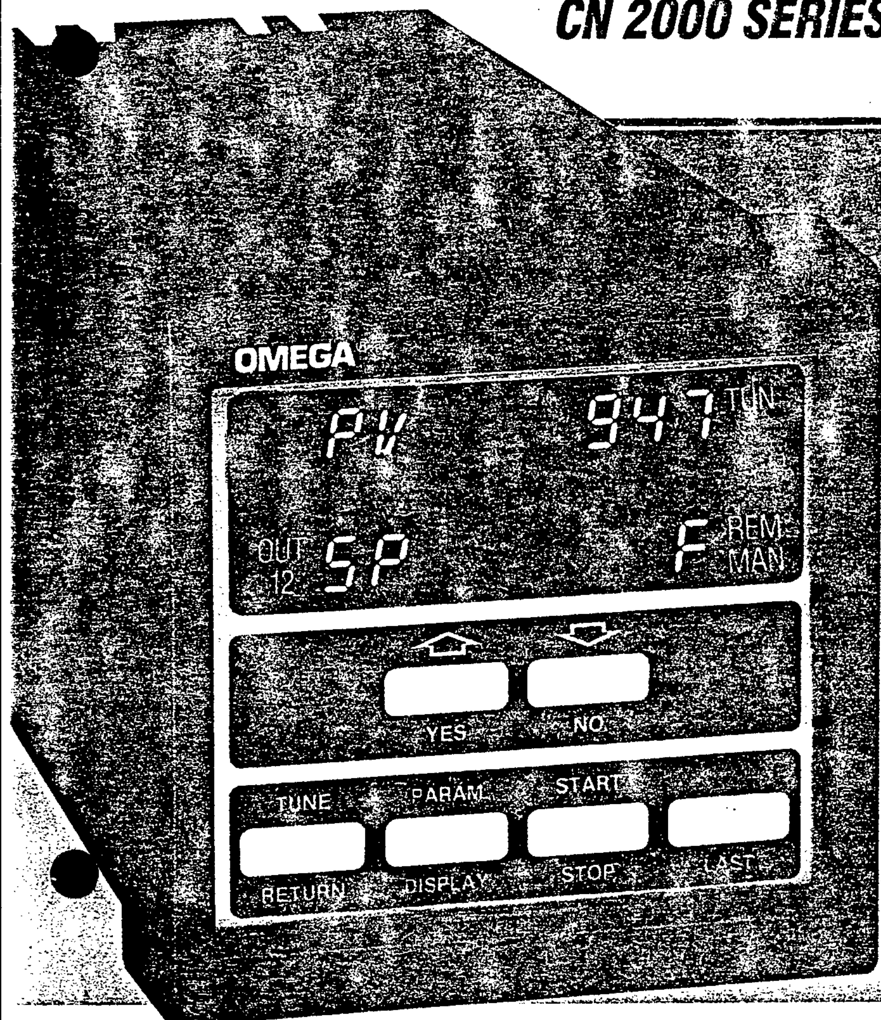
To Order (Specify Model Number)

RANGE Inches of H_2O	MODEL	PRICE	COMPATIBLE METER
NEMA-4 Enclosure Models			
0 to 1″	PX154-001DI	$305	DP100R8, DP2000P9, TX81
0 to 3″	PX154-003DI	305	DP100R8, DP2000P9, TX81
0 to 5″	PX154-005DI	305	DP100R8, DP2000P9, TX81
0 to 10″	PX154-010DI	305	DP100R8, DP2000P9, TX81
0 to 25″	PX154-025DI	305	DP100R8, DP2000P8, TX81
Conduit Enclosure Models			
0 to 1″	PX150-001DI	315	DP100R8, DP2000P9, TX81
0 to 3″	PX150-003DI	315	DP100R8, DP2000P9, TX81
0 to 5″	PX150-005DI	315	DP100R8, DP2000P9, TX81
0 to 10″	PX150-010DI	315	DP100R8, DP2000P9, TX81
0 to 25″	PX150-025DI	315	DP100R8, DP2000P8, TX81

4-10

PROCESS CONTROLLER
CN 2000 SERIES

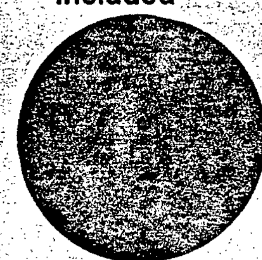
MADE IN USA



- For Millivolt, Volt and Milliamp Transducers
- RS-232 and RS-422 Communication for Remote Control through a Computer System
- Wide Variety of Output and Alarm Options Available

Features

- PID Control
- User Friendly Tuning Via Front Keypad
- Continuous Indication of Output, Alarm, and Operating Status
- Comprehensive Manual Included



To Order (Specify model number)

Model No.	Price	1st Output and Mode	2nd Output and Mode	Alarms
CN2001 (*)	$415	1A SSR PID	—	None
CN2002 (*)	445		1 A SSR, ON/OFF	
CN2001A (*)	465		—	Dual
CN2002A (*)	505		1A SSR, ON/OFF	

*Insert input code. Price includes range premiums.

INPUT TYPES

Code	Range	Type
mA	4-20 mA	Current
mV	0-100 mV dc	Voltage
V5	0-5 V dc	Voltage
V10	0-10 V dc	Voltage

Units factory scaled for 0-100% display. Zero and span field selectable. Max. display is 3200 counts.

OUTPUT OPTIONS

Ordering Suffix	Price	Description
-F1	N/C	4-20mA, output 1, reverse
-F2	N/C	4-20mA, output 2, direct
-DC1	N/C	0-5 Vdc, output 1, reverse
-DC2	N/C	0-5 Vdc, output 2, direct

EXCITATION OPTIONS*

Excitation	Code	Price	Description
5 V dc	X5 V	$50	5 V dc @ 40 mA
10 V dc	X10 V	50	10 V dc @ 100 mA

*Not Available with Options D2-D6 or Model CN2000A.

COMMUNICATION OPTIONS

Code	Price	Description
D1	$ 50	remote analog setpoint (n/a with 2000A)
D2	195	non-isolated RS-232C
D3	195	isolated RS-232C
D4	195	non-isolated RS-422
D5	195	isolated RS-422
D6	195	isolated 20 mA loop
D7	50	remote start/stop (N/A with 2000A)

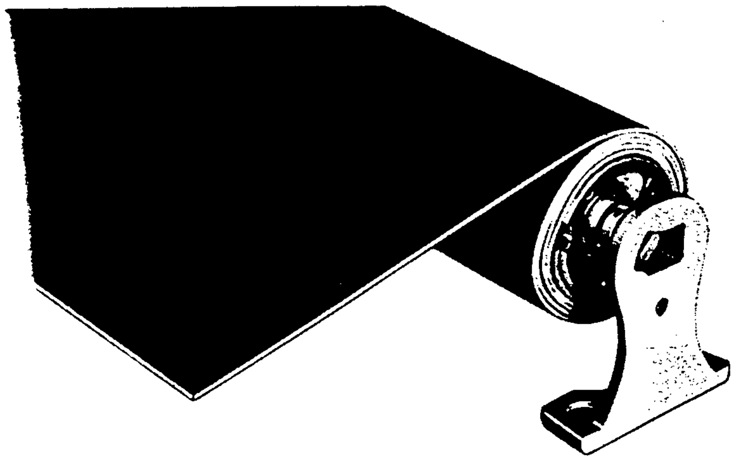
Also Available Auto/Manual Output Control. To Order, Add Suffix AM to Model No., and Add $50 to Price.

 4-11

GORTITE

SHADE ROLLER COVERS

PROTECT WAYS AGAINST CHIPS AND COOLANTS

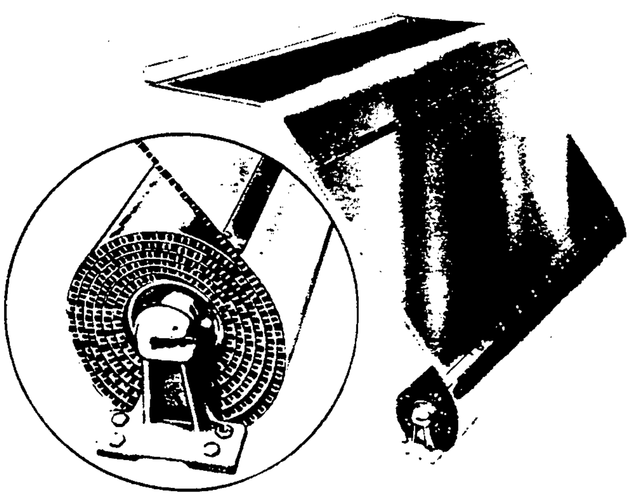


GORTITE SHADE ROLLERS AND COVERS ARE AVAILABLE FOR ALL APPLICATIONS THAT REQUIRE PROTECTION FROM CHIPS, ABRASIVES, OIL AND COOLANTS WITHOUT THE SEAL OF A BELLOWS COVER. VARIOUS DIAMETER SPRING LOADED METAL ROLLERS ARE AVAILABLE WITH COVER MATERIALS TO SUIT THE SIZE AND SEVERITY OF THE APPLICATION.

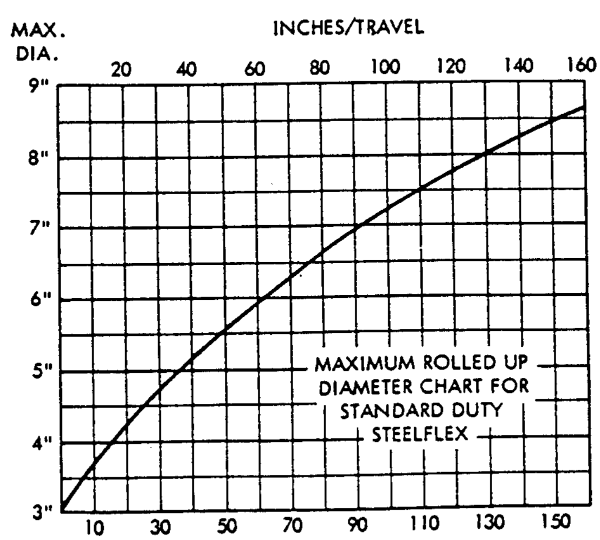
— DESCRIPTION OF COVER MATERIALS —

COVER MATERIALS *	DESCRIPTION
18NN	.018 GAUGE NEOPRENE COATED NYLON - FOR LIGHT DUTY PROTECTION AGAINST COOLANTS AND CHIPS
33NN	.033 GAUGE NEOPRENE COATED NYLON - FOR MODERATE DUTY PROTECTION AGAINST COOLANTS AND CHIPS
60HN	.060 GAUGE HYPALON COATED NYLON - HEAVY DUTY PROTECTION AGAINST ABRASION, COOLANT, AND CHIPS INCLUDING MODERATE HOT CHIP LOADS
STANDARD DUTY STEELFLEX	CONTINUOUS STAINLESS STEEL TOP SURFACE WITH SUPPORTING ALUMINUM RIBS. FOR HEAVY DUTY PROTECTION AGAINST LARGE CHIP LOADS, COOLANT, HOT CHIPS, ETC.

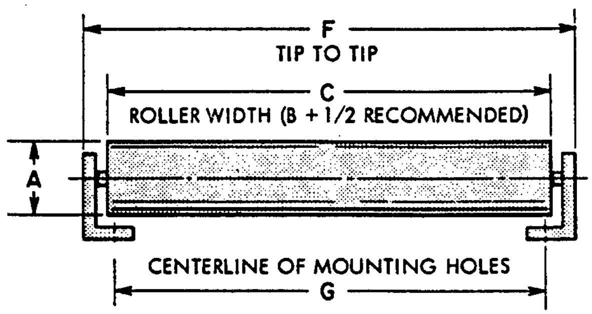
*SPECIAL MATERIALS AVAILABLE UPON REQUEST.

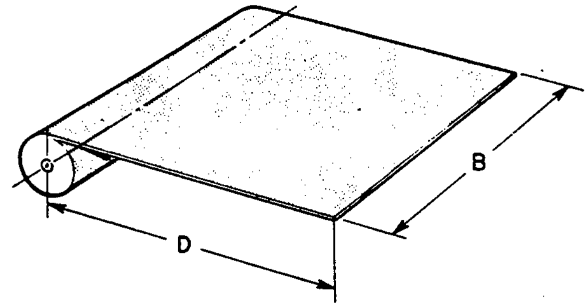


STANDARD DUTY STEELFLEX ON SPRING LOADED ROLLER



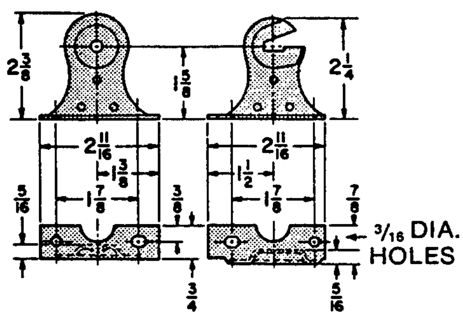
— ROLLER DIMENSIONS AND COVER MATERIALS —



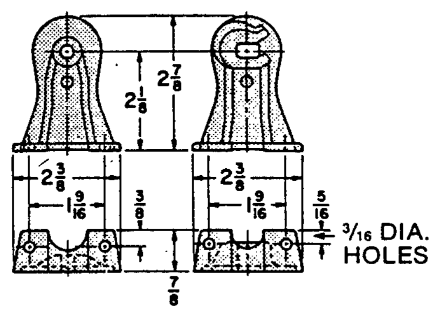


ROLLER DIAMETER	TIP TO TIP	CENTERLINE OF MTG. HOLES	COVER MATERIALS AVAILABLE ON VARIOUS ROLLER DIAMETERS			
A	F	G	18NN	33NN	60HN	STD. DUTY STEELFLEX
1-1/2"	C + 1-1/8"	C + 1/8"	X			
2" HD	C + 1-5/16"	C + 5/16"	X	X	X	
3" HD	C + 1-1/2"	C-1 1/4", C + 1/2"	X	X	X	X

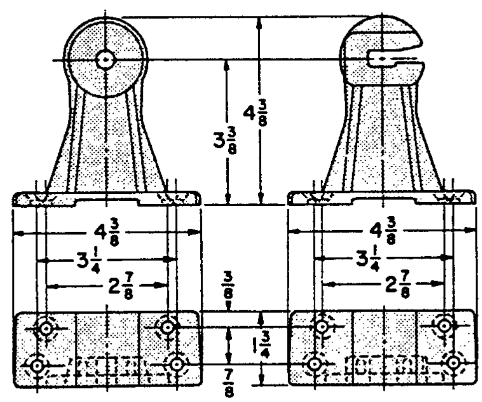
— DIMENSIONS OF ROLLER MOUNTING BRACKETS —



1-1/2" DIAMETER ROLLER



2" DIAMETER ROLLER



¼ DI.
HOL

3" DIAMETER ROLLER

— HOW TO ORDER —

TO ORDER OR FOR QUOTATION, PLEASE SPECIFY THE FOLLOWING DIMENSIONS AND INFORMATION.

A ROLLER DIAMETER ______________

B COVER WIDTH ______________
(WAY WIDTH + 2" RECOMMENDED)

C ROLLER WIDTH ______________
(COVER + 1/2" RECOMMENDED)

D MAX. OPEN LENGTH OF COVER ______________
(FOR _____ MACHINE TRAVEL)

MAX. MACHINE TRAVEL SPEED ____________ IN./MIN.

COVER MATERIAL PREFERRED

_________18NN_________33NN_________60HN

_________STANDARD DUTY STEELFLEX_________OTHER

_______WITH_______WITHOUT MOUNTING BRACKETS

DATE _________ FOR QUOTATION ONLY __________

QUANTITY REQUIRED ______________

DATE REQUIRED ______________

ORDER NUMBER ______________

COMPANY NAME ______________

ADDRESS ______________

CITY ____________ STATE __________ ZIP ________

ATTENTION ______________

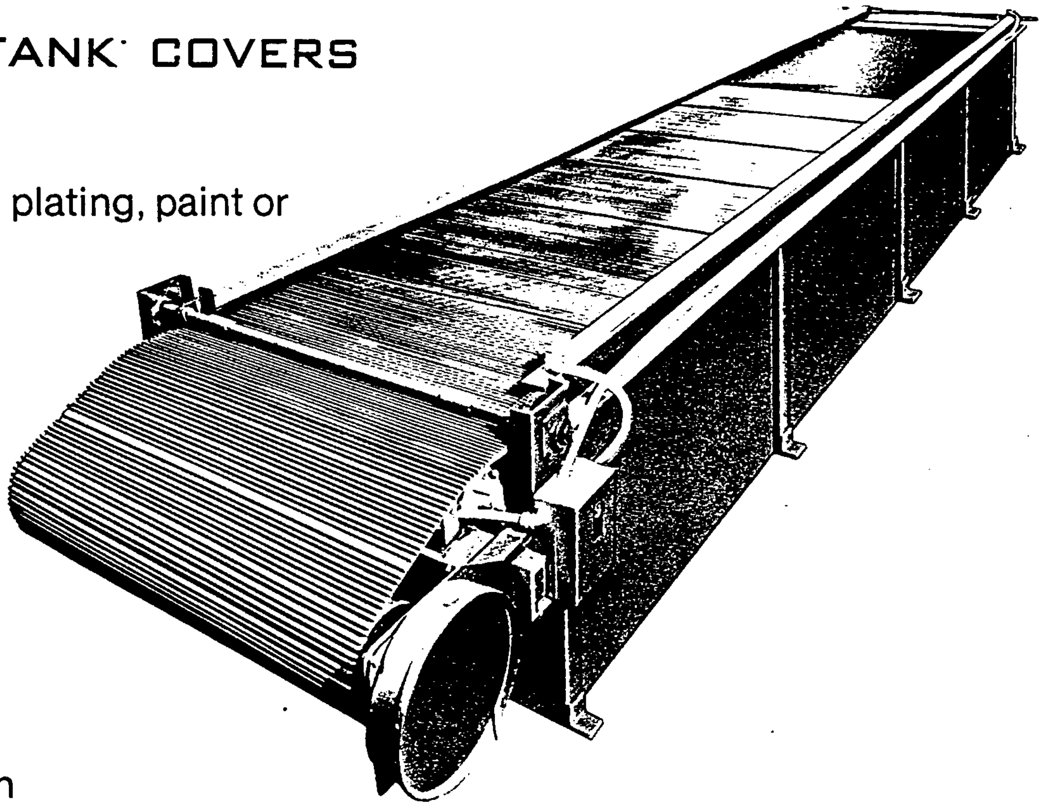
PLEASE BE SURE YOU HAVE FILLED IN AS MUCH OF THE REQUESTED INFORMATION AS IS AVAILABLE.

A and A Manufacturing Company 2300 So. Calhoun Rd., New Berlin, Wis. 53151 • Phone 414-786-1500

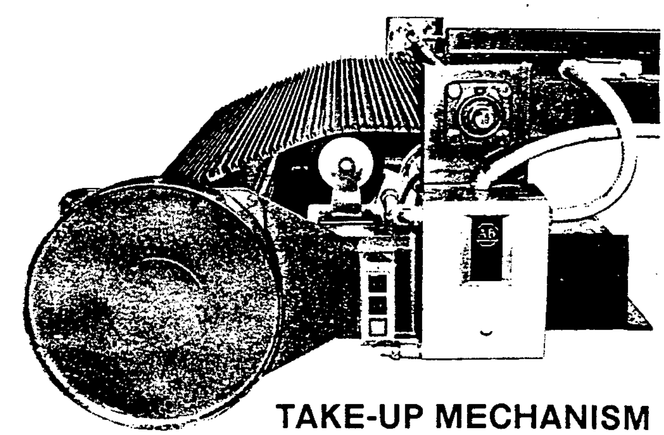
STEELFLEX®

MOTOR-DRIVEN TANK COVERS

for chemical, degreasing, plating, paint or any other type of tank



- Protect Personnel
- Control Evaporative Emissions For Energy Savings
- Prevent Contamination
- Contain Dangerous Fumes



TAKE-UP MECHANISM

CONSTRUCTION

STEELFLEX motor-driven tank covers are designed to provide a complete system for covering all types of tanks. Steelflex covers are made of continuous stainless steel surface reinforced with aluminum, steel or stainless steel support ribs which allow personnel to walk on the cover. The support ribs are bonded to top for strong, durable construction. Stainless steel or aluminum guide channels can be provided for the sides of the tank to contain the cover. Tank covers can be furnished stainless steel side on top or bottom. Any tank width or length can be accommodated.

Steelflex Tank Covers are supplied with electric motor drive and take-up mechanism with electrical control for forward, reverse and stop.

GORTITE

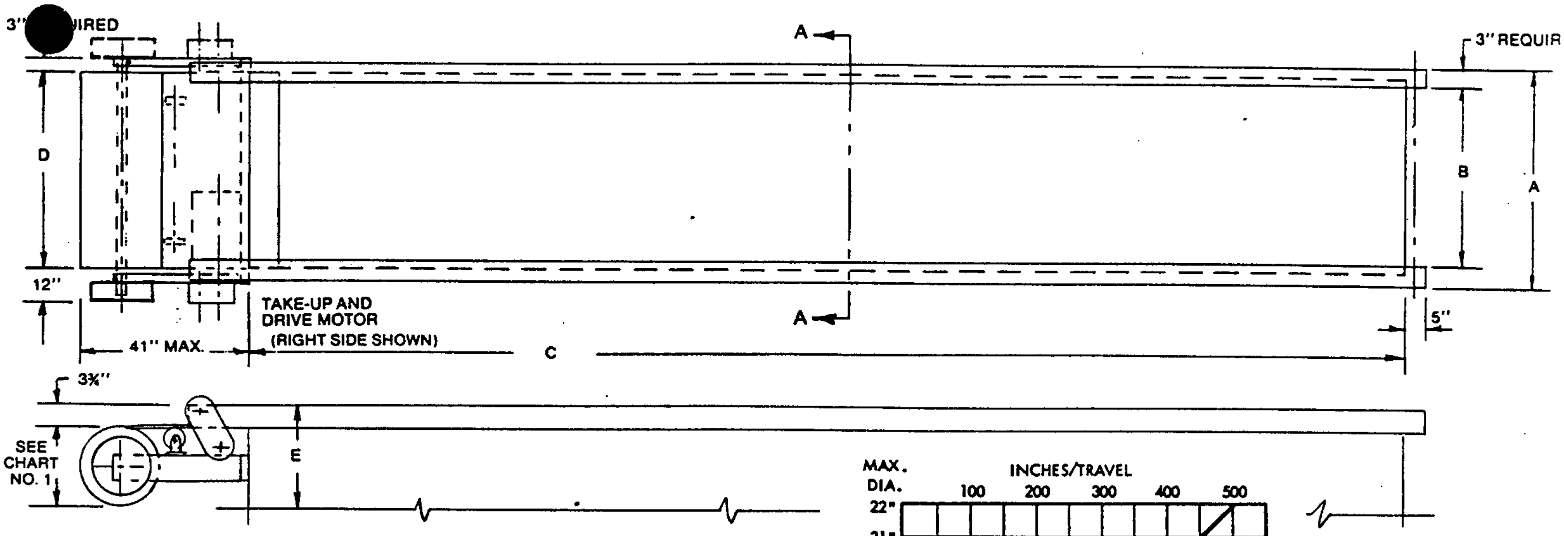
A and A Manufacturing Co. Inc.

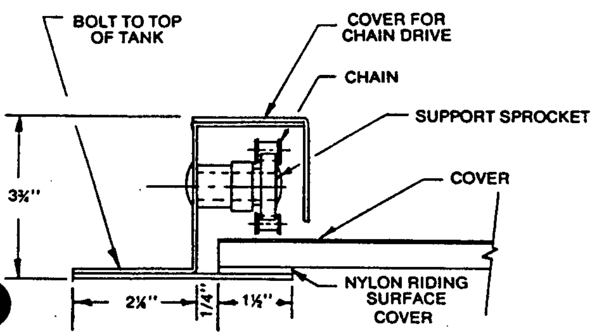
2300 South Calhoun Road
New Berlin, WI 53151 Phone 414-786-1500

STEELFLEX® MOTOR-DRIVEN

GORTITE

TANK COVERS DATA SHEET





SECTION AA

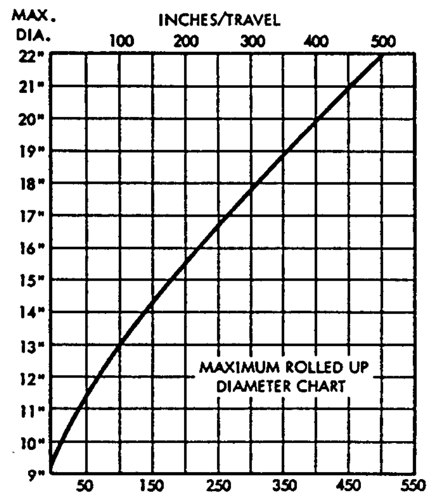


CHART NO. 1

HOW TO ORDER

TO ORDER OR FOR QUOTATION, PLEASE SPECIFY THE FOLLOWING DIMENSIONS AND INFORMATION.

A. OVERALL TANK WIDTH ____________

B. INSIDE TANK WIDTH ____________

C. OVERALL TANK LENGTH (INSIDE) ____________

D. COVER WIDTH ____________

E. TANK HEIGHT ABOVE FLOOR ____________

SUBSTANCE BEING COVERED ____________

TAKE-UP & DRIVE MOTOR LOCATION

RIGHT SIDE ________ LEFT SIDE ________

MOTOR STARTER VOLTAGE REQUIRED

________ VOLT ________ PHASE

DATE ______ FOR QUOTATION ONLY ____________

QUANTITY REQUIRED ____________

DATE REQUIRED ____________

ORDER NUMBER ____________

COMPANY NAME ____________

ADDRESS ____________

CITY ____________

STATE ____________ ZIP ________

ATTENTION ____________

TELEPHONE ____________

PLEASE BE SURE YOU HAVE FILLED IN AS MUCH OF THE REQUESTED INFORMATION AS IS AVAILABLE.

GORTITE®

A and A Manufacturing Co. Inc.

2300 South Calhoun Road
New Berlin, WI 53151 Phone 414-786-1500

ECO 5

Electrical Demand Peak Reduction

Assumptions:

1. Electric motors driving the process equipment are operating at 65% of full load.

2. The average motor efficiency is 88 %

3. The electric heating elements of the Selas Furnace draw about 500 KW.

4. Only one vertical furnace (in Bldg. 135) operates each day.

5. Only one of the Wellman Furnaces operates at any one time.

6. The equipment kw draws and operating times are:

	Stage 1	Stage 2
Tocco Furnace	1250 kw, .33 hr	625 kw, 1.17 hr
Rotary Forge	1650 kw, .33 hr	NA
Selas Furnace	636 kw, 24 hr	NA
Wellman Furnace	1000 kw, 1 hr	500 kw, 7 hr
Swage	227 kw, 0.5 hr	NA
Vertical furnace	471 kw, 3 hr	202 kw, 8 hr

ECO 5 - Continued

The motor kw was calculated on a computer spreadsheet. The results are located on page 5-4 of this appendix.

The total equipment kw was input into a spreadsheet, scheduled at random.

The results show a maximum kw draw of 4,465 kw at about 10:30 am. See page 5-5 for details.

The same pieces of equipment were then scheduled for various times during the day and input on the same spreadsheet.

The results show a maximum kw draw of 2286 kw (Say 2285) when the loads are properly scheduled. See page 5-6 for details.

KW savings = Unscheduled kw - Scheduled kw

Savings = 4465 kw/mo - 2285 kw/mo = 2180 kw/mo

Cost Savings:

2180 kw/mo x 12 mo/yr x \$5.53/kw = \$144,665/yr

ECO 5 - Continued

Construction Costs:

There are no direct installation cost for this project. It requires some industrial engineering and cooperation from the production staff.

Scheduled Process Equipment 08/09/91
Filename: EQUIP

	Equipment					
Equipment Description	Tocco	Forge	Selas	Wellman	Swage	V.Furn
Number of Machines	5	1	1	2	3	2
Operating Machines	1	1	1	1	1	1
Parts per Day	5	5	5	5	5	5
Hours per Part	1.5	0.3	13.1	8.0	0.5	12.0
Hours per Day	7.5	1.3	24.0	8.0	2.5	12.0
HP/Machine	0.0	2961.0	246.0	0.0	407.5	3.5
Total Horsepower	0.0	2961.0	246.0	0.0	407.5	3.5
Motor KW	0.0	1631.6	135.6	0.0	224.8	1.9
Heating KW	1250	0	500	1000	2	469
Total KW	1250	1632	636	1000	227	471

Assumptions:

1. Motors are operating at 65% of full load
2. Average motor efficiency is 88%
3. Selas furnace electric heat is 500 KW

Watervliet Operation Scheduling For Demand Reduction 08/09/91
Filename: OPSCHED

Daily Demand (KW) Load - Not Scheduled

Time	Selas	V. Furn	Tocco	Forge	Swage	Wellman	Total
0	636	471					1107
	636	471					1107
	636	471					1107
	636	471					1107
2	636	202					838
	636	202					838
	636	202					838
	636	202					838
4	636	202					838
	636	202					838
	636	202					838
	636	202					838
6	636	202					838
	636	202				1000	1838
	636	202				1000	1838
	636	202	1250			500	2588
8	636	202	625			500	1963
	636	202	625		227	500	2190
	636	202	1250	1650		500	4238
	636	202	625		227	500	2190
10	636	202	625			500	1963
	636	202	1250	1650	227	500	4465
	636		625			500	1761
	636		625		227	500	1988
12	636		1250	1650		500	4036
	636		625		227	500	1988
	636		625			500	1761
	636		1250	1650		500	4036
14	636		625			500	1761
	636		625				1261
	636			1650			2286
	636						636
16	636						636
	636						636
	636						636
	636						636
18	636						636
	636						636
	636						636
	636						636
20	636						636
	636						636
	636						636
	636						636
22	636						636
	636						636
	636	471					1107
	636	471					1107
Maximums	636	471	1250	1650	227	1000	4465

Watervliet Operation Scheduling For Demand Reduction 08/09/91
Filename: OPSCHED

Daily Demand (KW) Load - Scheduled

Time	Selas	V. Furn	Tocco	Forge	Swage	Wellman	Total
0	636	202				500	1338
	636	202				500	1338
	636	202					838
	636	202					838
2	636	202					838
	636	202					838
	636	202					838
	636	202					838
4	636	202					838
	636	202					838
	636	202					838
	636	202					838
6	636						636
	636		1250				1886
	636		625		227		1488
	636		625				1261
8	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
10	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
12	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
14	636			1650			2286
	636		1250				1886
	636		625		227		1488
	636		625				1261
16	636			1650			2286
	636						636
	636					1000	1636
	636					1000	1636
18	636	471				500	1607
	636	471				500	1607
	636	471				500	1607
	636	471				500	1607
20	636	471				500	1607
	636	471				500	1607
	636	202				500	1338
	636	202				500	1338
22	636	202				500	1338
	636	202				500	1338
	636	202				500	1338
	636	202				500	1338
Maximums	636	471	1250	1650	227	1000	2286

Watervliet Electric Demand Data
Filename: KWDATA

Month	Year	Billed KW	Billed Amount	Demand Charge
6	1990	10818.7	$53,270.03	$4.92
7	1990	11205.0	$55,172.13	$4.92
8	1990	11011.9	$54,942.35	$4.99
9	1990	11205.0	$55,905.80	$4.99
10	1990	11591.4	$57,833.69	$4.99
11	1990	10818.7	$53,978.41	$4.99
12	1990	11591.4	$57,833.69	$4.99
1	1991	10239.1	$56,079.04	$5.48
2	1991	10432.3	$57,736.85	$5.53
3	1991	10142.5	$56,132.97	$5.53
4	1991	10915.3	$60,409.98	$5.53
5	1991	11108.4	$61,478.68	$5.53
Maximum		11591.4	$61,478.68	$5.53
Average		10923.3	$56,731.14	$5.20
Total			$680,773.62	

Watervliet Demand And Power Factor Data
Filename: ELECDATA

6/13/90

Hour	Metered KW	Demand KW	Metered KVAR	Reactive KVAR	KVA	PF
0	191	5500.8	135	4665.6	7212.9	0.763
	192	5529.6	139	4803.8	7324.8	0.755
	194	5587.2	141	4873.0	7413.7	0.754
	192	5529.6	142	4907.5	7393.3	0.748
1	193	5558.4	141	4873.0	7392.0	0.752
	194	5587.2	141	4873.0	7413.7	0.754
	195	5616.0	146	5045.8	7549.8	0.744
	194	5587.2	144	4976.6	7482.2	0.747
2	192	5529.6	142	4907.5	7393.3	0.748
	193	5558.4	143	4942.1	7437.7	0.747
	192	5529.6	144	4976.6	7439.3	0.743
	198	5702.4	146	5045.8	7614.3	0.749
3	195	5616.0	145	5011.2	7526.7	0.746
	195	5616.0	144	4976.6	7503.8	0.748
	193	5558.4	143	4942.1	7437.7	0.747
	189	5443.2	139	4803.8	7259.8	0.750
4	186	5356.8	137	4734.7	7149.3	0.749
	184	5299.2	136	4700.2	7083.3	0.748
	184	5299.2	135	4665.6	7060.4	0.751
	186	5356.8	137	4734.7	7149.3	0.749
5	188	5414.4	140	4838.4	7261.3	0.746
	188	5414.4	139	4803.8	7238.3	0.748
	188	5414.4	137	4734.7	7192.6	0.753
	194	5587.2	139	4803.8	7368.4	0.758
6	196	5644.8	138	4769.3	7389.8	0.764
	196	5644.8	138	4769.3	7389.8	0.764
	198	5702.4	136	4700.2	7389.8	0.772
	204	5875.2	133	4596.5	7459.6	0.788
7	211	6076.8	132	4561.9	7598.6	0.800
	243	6998.4	132	4561.9	8354.0	0.838
	275	7920.0	154	5322.2	9542.2	0.830
	304	8755.2	176	6082.6	10660.7	0.821
8	315	9072.0	184	6359.0	11078.7	0.819
	313	9014.4	187	6462.7	11091.7	0.813
	312	8985.6	181	6255.4	10948.5	0.821
	310	8928.0	186	6428.2	11001.4	0.812
9	308	8870.4	185	6393.6	10934.4	0.811
	306	8812.8	189	6531.8	10969.5	0.803
	311	8956.8	199	6877.4	11292.6	0.793
	322	9273.6	210	7257.6	11775.9	0.788
10	320	9216.0	207	7153.9	11666.8	0.790
	337	9705.6	214	7395.8	12202.3	0.795
	327	9417.6	213	7361.3	11953.2	0.788
	318	9158.4	211	7292.2	11706.9	0.782
11	319	9187.2	212	7326.7	11751.0	0.782
	319	9187.2	202	6981.1	11538.7	0.796
	305	8784.0	192	6635.5	11008.6	0.798
	293	8438.4	191	6601.0	10713.5	0.788
12	298	8582.4	202	6981.1	11063.2	0.776
	319	9187.2	218	7534.1	11881.4	0.773

0/12/90

	332	9561.6	219	7568.6	12194.6	0.784
	328	9446.4	218	7534.1	12082.9	0.782
13	317	9129.6	213	7361.3	11727.7	0.778
	325	9360.0	212	7326.7	11886.6	0.787
	319	9187.2	213	7361.3	11772.6	0.780
	335	9648.0	221	7637.8	12305.3	0.784
14	324	9331.2	217	7499.5	11971.4	0.779
	318	9158.4	220	7603.2	11903.1	0.769
	292	8409.6	203	7015.7	10951.8	0.768
	275	7920.0	186	6428.2	10200.4	0.776
15	270	7776.0	182	6289.9	10001.5	0.777
	268	7718.4	179	6186.2	9891.6	0.780
	258	7430.4	165	5702.4	9366.3	0.793
	241	6940.8	155	5356.8	8767.6	0.792
16	233	6710.4	155	5356.8	8586.3	0.782
	238	6854.4	167	5771.5	8960.6	0.765
	237	6825.6	171	5909.8	9028.5	0.756
	237	6825.6	172	5944.3	9051.2	0.754
17	234	6739.2	170	5875.2	8940.6	0.754
	238	6854.4	174	6013.4	9118.3	0.752
	238	6854.4	173	5978.9	9095.6	0.754
	235	6768.0	170	5875.2	8962.4	0.755
18	240	6912.0	169	5840.6	9049.2	0.764
	242	6969.6	169	5840.6	9093.3	0.766
	256	7372.8	177	6117.1	9580.0	0.770
	234	6739.2	164	5667.8	8805.7	0.765
19	244	7027.2	170	5875.2	9159.7	0.767
	228	6566.4	158	5460.5	8540.2	0.769
	222	6393.6	153	5287.7	8296.8	0.771
	218	6278.4	153	5287.7	8208.4	0.765
20	219	6307.2	152	5253.1	8208.3	0.768
	214	6163.2	150	5184.0	8053.5	0.765
	221	6364.8	157	5425.9	8363.7	0.761
	222	6393.6	160	5529.6	8453.1	0.756
21	224	6451.2	161	5564.2	8519.3	0.757
	219	6307.2	161	5564.2	8410.7	0.750
	221	6364.8	161	5564.2	8454.0	0.753
	220	6336.0	162	5598.7	8455.2	0.749
22	215	6192.0	160	5529.6	8301.6	0.746
	218	6278.4	160	5529.6	8366.3	0.750
	213	6134.4	157	5425.9	8189.7	0.749
	211	6076.8	154	5322.2	8078.0	0.752
23	209	6019.2	153	5287.7	8011.9	0.751
	204	5875.2	151	5218.6	7858.2	0.748
	204	5875.2	147	5080.3	7767.1	0.756
	200	5760.0	146	5045.8	7657.5	0.752

Watervliet Demand And Power Factor Data
Filename: ELECDATA

6/14/90

Hour	Metered KW	Demand KW	Metered KVAR	Reactive KVAR	KVA	PF
0	201	5788.8	147	5080.3	7701.9	0.752
	198	5702.4	145	5011.2	7591.4	0.751
	197	5673.6	144	4976.6	7547.0	0.752
	200	5760.0	149	5149.4	7726.2	0.746
1	199	5731.2	151	5218.6	7751.1	0.739
	200	5760.0	152	5253.1	7795.7	0.739
	200	5760.0	154	5322.2	7842.4	0.734
	203	5846.4	158	5460.5	7999.8	0.731
2	200	5760.0	153	5287.7	7819.0	0.737
	195	5616.0	151	5218.6	7666.3	0.733
	195	5616.0	152	5253.1	7689.9	0.730
	194	5587.2	152	5253.1	7668.9	0.729
3	191	5500.8	151	5218.6	7582.4	0.725
	195	5616.0	154	5322.2	7737.3	0.726
	193	5558.4	152	5253.1	7647.9	0.727
	195	5616.0	151	5218.6	7666.3	0.733
4	188	5414.4	148	5114.9	7448.3	0.727
	185	5328.0	144	4976.6	7290.7	0.731
	187	5385.6	144	4976.6	7332.9	0.734
	189	5443.2	147	5080.3	7445.7	0.731
5	189	5443.2	147	5080.3	7445.7	0.731
	190	5472.0	149	5149.4	7514.0	0.728
	196	5644.8	150	5184.0	7664.0	0.737
	199	5731.2	148	5114.9	7681.7	0.746
6	206	5932.8	150	5184.0	7878.6	0.753
	227	6537.6	150	5184.0	8343.5	0.784
	233	6710.4	147	5080.3	8416.6	0.797
	235	6768.0	152	5253.1	8567.4	0.790
7	265	7632.0	154	5322.2	9304.5	0.820
	275	7920.0	154	5322.2	9542.2	0.830
	294	8467.2	164	5667.8	10189.1	0.831
	309	8899.2	183	6324.5	10917.6	0.815
8	322	9273.6	207	7153.9	11712.3	0.792
	313	9014.4	214	7395.8	11660.1	0.773
	335	9648.0	217	7499.5	12219.9	0.790
	327	9417.6	216	7465.0	12017.4	0.784
9	316	9100.8	216	7465.0	11770.7	0.773
	318	9158.4	216	7465.0	11815.3	0.775
	304	8755.2	211	7292.2	11394.3	0.768
	325	9360.0	221	7637.8	12080.8	0.775
10	339	9763.2	223	7706.9	12438.5	0.785
	336	9676.8	223	7706.9	12370.8	0.782
	347	9993.6	233	8052.5	12834.1	0.779
	364	10483.2	238	8225.3	13324.9	0.787
11	375	10800.0	232	8017.9	13450.9	0.803
	328	9446.4	210	7257.6	11912.5	0.793
	305	8784.0	198	6842.9	11134.8	0.789
	310	8928.0	200	6912.0	11290.9	0.791
12	317	9129.6	215	7430.4	11771.2	0.776
	320	9216.0	221	7637.8	11969.5	0.770

5-10

6/14/90

	337	9705.6	220	7603.2	12329.1	0.787
	334	9619.2	222	7672.3	12304.2	0.782
13	328	9446.4	219	7568.6	12104.5	0.780
	300	8640.0	208	7188.5	11239.4	0.769
	311	8956.8	209	7223.0	11506.4	0.778
	317	9129.6	217	7499.5	11814.9	0.773
14	315	9072.0	216	7465.0	11748.5	0.772
	297	8553.6	211	7292.2	11240.1	0.761
	302	8697.6	207	7153.9	11261.7	0.772
	280	8064.0	185	6393.6	10291.1	0.784
15	271	7804.8	179	6186.2	9959.1	0.784
	265	7632.0	175	6048.0	9737.9	0.784
	251	7228.8	161	5564.2	9122.2	0.792
	238	6854.4	149	5149.4	8573.2	0.800
16	228	6566.4	152	5253.1	8409.1	0.781
	233	6710.4	159	5495.0	8673.2	0.774
	230	6624.0	160	5529.6	8628.7	0.768
	227	6537.6	159	5495.0	8540.2	0.766
17	239	6883.2	168	5806.1	9004.9	0.764
	230	6624.0	168	5806.1	8808.4	0.752
	249	7171.2	176	6082.6	9403.4	0.763
	233	6710.4	165	5702.4	8806.1	0.762
18	222	6393.6	160	5529.6	8453.1	0.756
	222	6393.6	160	5529.6	8453.1	0.756
	219	6307.2	159	5495.0	8365.2	0.754
	220	6336.0	160	5529.6	8409.6	0.753
19	219	6307.2	156	5391.4	8297.4	0.760
	214	6163.2	155	5356.8	8165.8	0.755
	214	6163.2	146	5045.8	7965.2	0.774
	215	6192.0	144	4976.6	7944.0	0.779
20	211	6076.8	140	4838.4	7767.7	0.782
	211	6076.8	142	4907.5	7811.0	0.778
	214	6163.2	142	4907.5	7878.4	0.782
	215	6192.0	147	5080.3	8009.4	0.773
21	215	6192.0	148	5114.9	8031.4	0.771
	216	6220.8	150	5184.0	8097.7	0.768
	217	6249.6	153	5287.7	8186.4	0.763
	215	6192.0	153	5287.7	8142.5	0.760
22	213	6134.4	151	5218.6	8053.8	0.762
	214	6163.2	153	5287.7	8120.6	0.759
	213	6134.4	153	5287.7	8098.8	0.757
	206	5932.8	148	5114.9	7833.3	0.757
23	204	5875.2	145	5011.2	7722.1	0.761
	200	5760.0	142	4907.5	7567.1	0.761
	200	5760.0	137	4734.7	7456.2	0.773
	197	5673.6	134	4631.0	7323.7	0.775

RS&H®

SUBJECT	ECO #6 - Plating Area Condensate Return	AEP NO	290-0379-002
		SHEET	OF
DESIGNER	P. Hutchins	DATE	7/11/91
CHECKER	B. Todd	DATE	9/16/91

ECO#6 - PLATING AREA CONDENSATE RETURN

- Estimate existing energy use for making steam

<u>FY 90</u>

BLDG 136 — 278,000 MBTU FSR

BLDG 35 - 29,500 MBTU NGAS

- Calculate total steam generated

Stm = FUEL USE * BLR EFF (App B, p. I-11)

	BLR EFF	MBtu	#
BLDG 136	0.83	230,700	232,133,000
BLDG 35	0.77	22,700	22,852,000

- Estimate condensate to be returned from plating areas

Since Bldg 35 boiler supplies only the plating areas and no condensate is returned, the steam production during the summer months will be a good approximation for year-round use.

Average steam production for Aug and Sept '90

$(3{,}676{,}600 + 3{,}983{,}500) / 2 \approx 3{,}830{,}000$ #/mon.

Plating area annual steam use is $\Rightarrow$ $3{,}830{,}000 \times 12 \approx$ <u>45,960,000</u> #/yr

$\approx$ <u>46,000</u> MBTu/yr

SUBJECT ECO #6

AEP NO

SHEET / OF

DESIGNER

DATE 7/11/91

CHECKER

DATE

- Calculate energy savings by returning plating area condensate

Assume 90% is returned at 180°F to Bldg 35 and 150°F to Bldg 136.

$$\text{Fuel Energy Saved} = \frac{\text{condensate amount} * (\text{cond. temp} - \text{make-up temp.})}{\text{BOILER EFF}}$$

$$\text{Bldg 35} \Rightarrow \frac{22,852,000^{\#} * (180 - 60)^{\circ}F * 1 \frac{Btu}{lb^{\circ}F} * 0.9}{0.77}$$

$$= \underline{3205 \text{ MBtu}} \text{ Natural gas}$$

$$\underline{\text{Bldg}} \text{ 136} \Rightarrow \frac{(45,960,000 - 22,852,000) * (150 - 60) * 0.9}{0.83}$$

$$= \underline{2255 \text{ MBtu}} \text{ \#6 Fuel Oil}$$

RS&H®

SUBJECT ECO#6

AEP NO

SHEET OF

DESIGNER

DATE

CHECKER

DATE

QRIP Calc.s

- Calculate present, proposed and savings costs

Present annual energy use to Bldg. 35 plating is estimated using natural gas use at donkey boiler in Bldg #35

	Steam (lbs)	Steam (MBtu)	Nat. Gas (MCF)	Nat. Gas (MBtu)
June '90	4,110,000	4110	51,373	5291
July '90	2,572,000	2572	32,494	3347
Aug. '90	3,676,000	3676	46,329	4772
Sept. '90	3,984,000	3984	49,696	5119
Oct. '90	3,155,000	3155	37,780	3891

Using Aug and Sept as avg., monthly use is:

steam $= \frac{3676 + 3984}{2} = \underline{3830}$ MBtu/mon.

n. gas $= \frac{4772 + 5119}{2} = \underline{\underline{4946}}$ MBtu/mon.

Annual Ngas $= 4946 \frac{MBtu}{mon} * 5 \text{ mos} * \frac{\$4.16}{MBtu} = \underline{\$102,900}$

Annual #6 Fuel Oil $= 3830 \frac{MBtu}{mon} \div 0.83 * 7 \text{ mos} * \frac{\$4.40}{MBtu} = \underline{\$142,100}$

TOTAL ENERGY COST $= \underline{\underline{\$245,000}}$

RS&H®

SUBJECT ECO #6

AEP NO

SHEET OF

DESIGNER

DATE

CHECKER

DATE

- Cost of proposed method

N Gas = $(4946 * 5 - 3205) * 4.16$ = $89,500

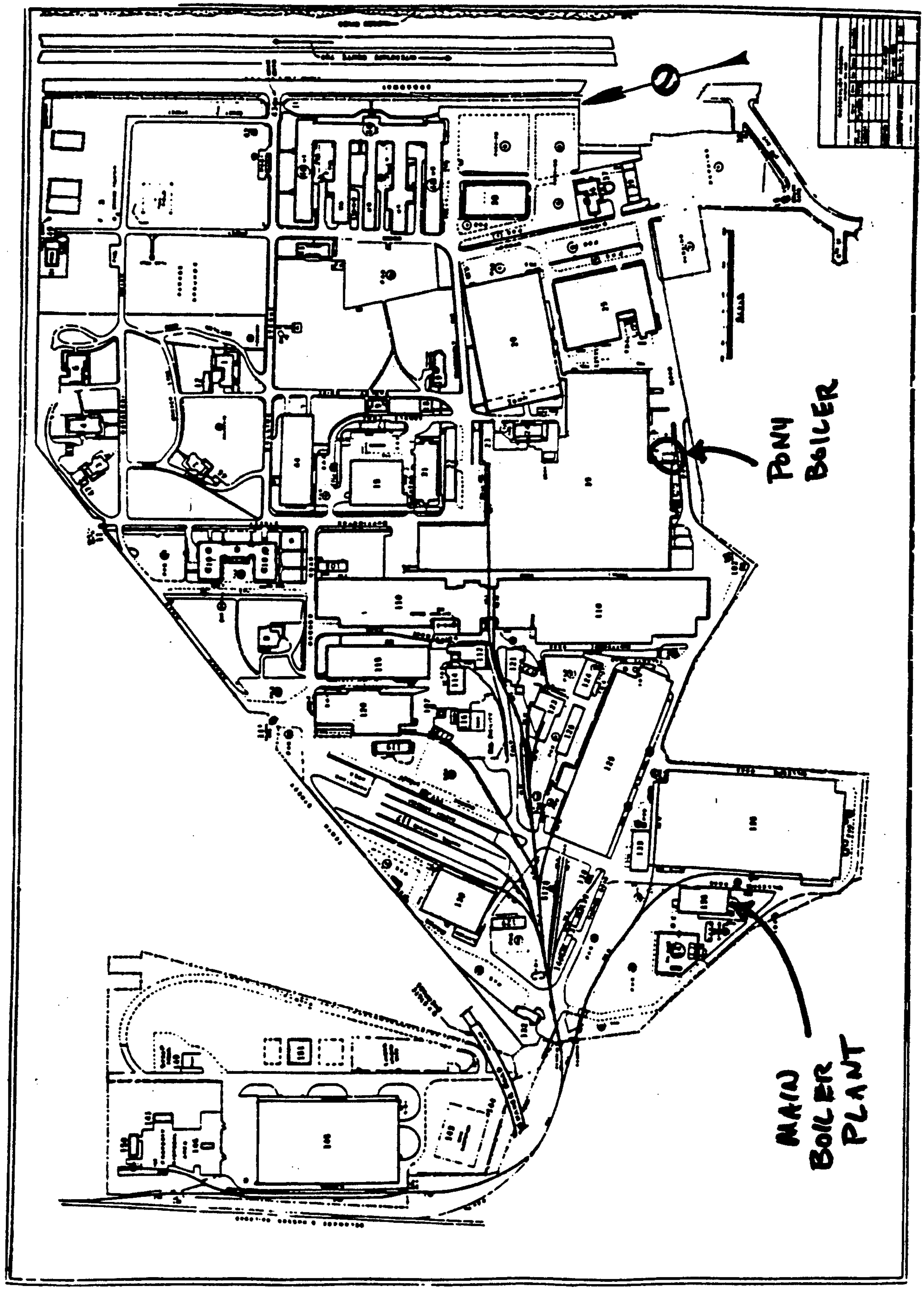
#6 Fuel Oil = $\left(\frac{3830}{0.83} * 7 - 2255\right) * 4.40$ = $132,200

Total $221,700

- Savings, annual

$245,000
- 221,700

$23,300


PONY BOILER
MAIN BOILER PLANT

SUBJECT

AEP NO

SHEET OF

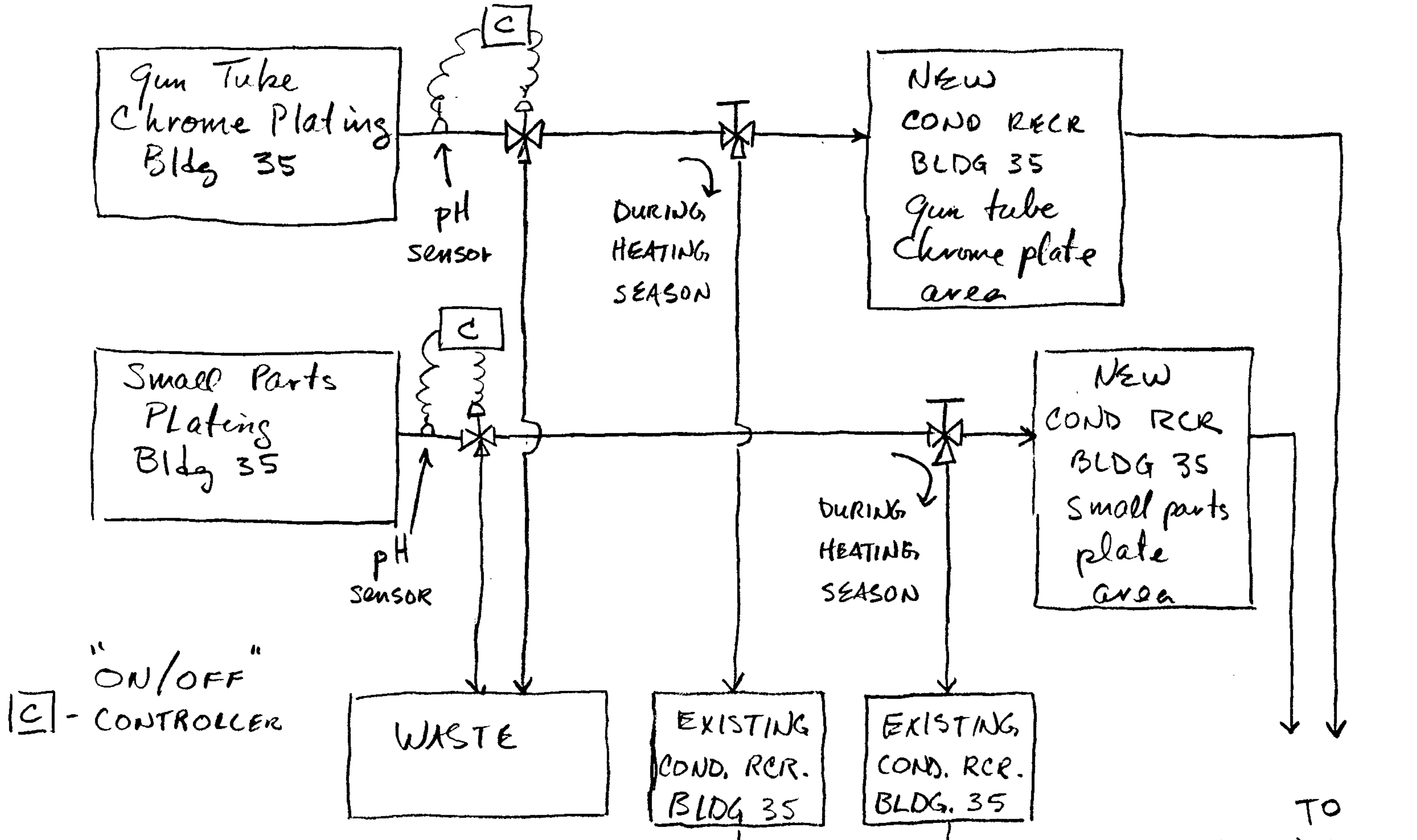
DESIGNER P. Hutchins

DATE

CHECKER

DATE

CONDENSATE RETURN SYSTEM SCHEMATIC



- Existing system flows to waste
- New system consist of
  - 2 cond. rcr. tanks
  - 2 manual 3-way valves
  - 2 pH sensors and controls for 2 motorized 3-way valves.

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: PLATING AREA STEAM CONDENSATE RETURN

ECO #: 6

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$6,370
Labor		$4,040
	Subtotal bare costs	$10,410
FICA Insurance (20% of Labor)		$808
Sales Tax (not applicable for GOGO)		$0
	Subtotal	$11,218
Overhead (15%)		$1,683
	Subtotal	$12,901
Profit (10%)		$1,290
	Subtotal	$14,191
Bond (1%)		$142
	Subtotal	$14,333
Contingency (10%)		$1,433
Subtotal (Construction Cost Input For LCCID *)		$15,766
SIOH (6% of Construction Cost)		$946
	Subtotal	$16,712
Design (6% of Construction Cost)		$946
Total Project Cost		$17,658

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED: 8/7/91
SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS
LOCATION: WATERVLIET ARSENAL
ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.
DRAWING NO.:
ESTIMATOR: P. Hutchins
CHECKED BY:

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

ECO # 6 SUMMARY Condensate Return	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
1" steel pipe, threaded, black, with couplings and hangars 10' O.C	800	ft	3.84	3070	1.49	1190	4260
Condensate Return Sys. Simplex, motor, float switch, controls, cast iron receiver	2	ea	365	730	955	1910	2640
pH Controllers	2	ea	25	50	650	1300	1350
Electrodes (sensors)	2	ea	25	50	250	500	550
3-WAY VALVE WITH ACTUATOR	2	ea	25	50	600	1200	1250
3-WAY VALVE, MANUAL	2	ea	25	50	125	250	270
WIRING	2	CLF	20	40	10	20	60
				4040		6370	10,380

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

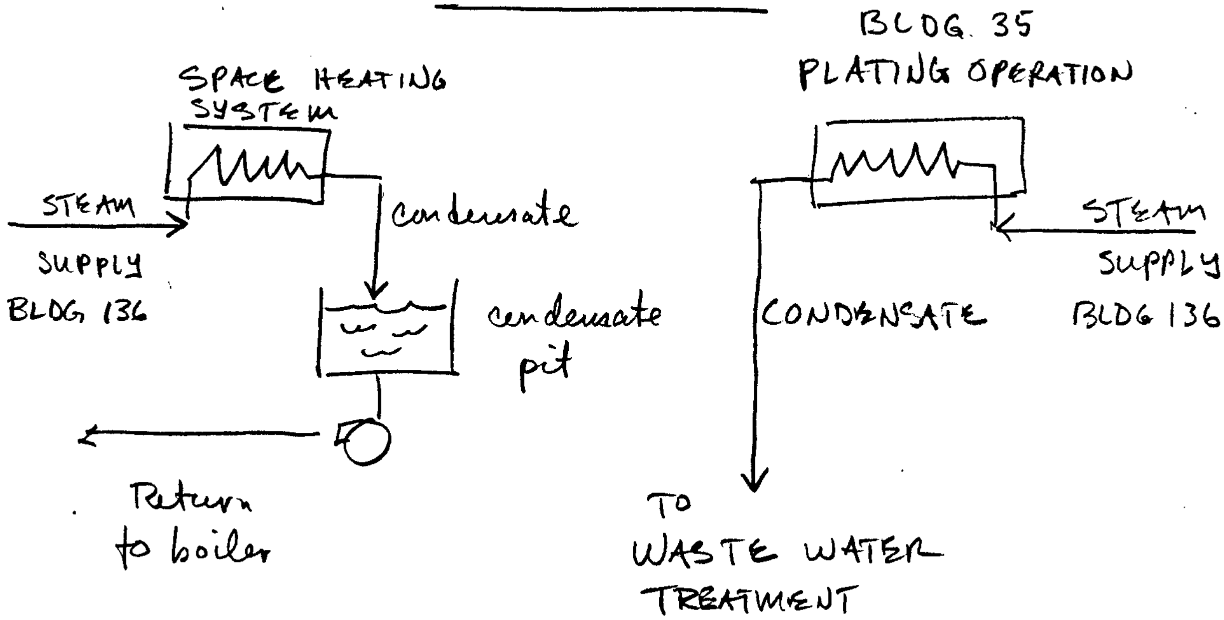
RS&H

SUBJECT ECO # 6
COST ESTIMATE BACKUP
DESIGNER
CHECKER

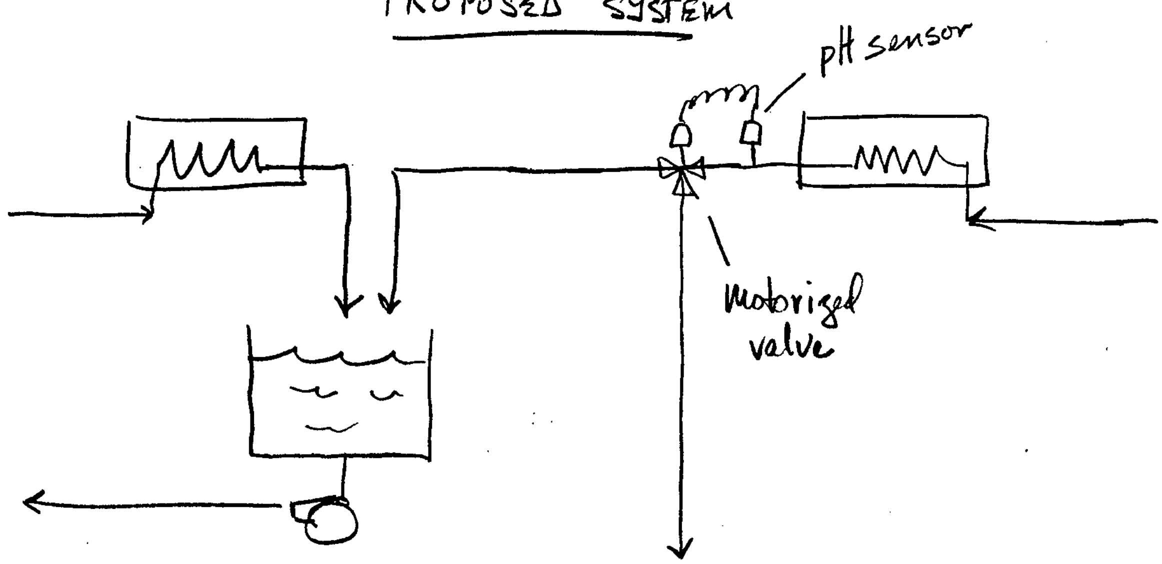
AEP NO
SHEET OF
DATE
DATE

Non-Summer Operation – Condensate return to Bldg 136

EXISTING SYSTEMS



PROPOSED SYSTEM



- The proposed system will require piping between the existing plating system condensate lines and the condensate pit, a motorized valve, pH sensor and associated controls. The pH sensor is used to divert the condensate to waste when the pH drops below a preset value.

SUBJECT ECO #6

AEP NO

SHEET OF

DESIGNER

DATE

CHECKER

DATE

Summer Operation - Condensate return to Bldg 35 boiler

Since the Bldg. 35 boiler has no condensate return system, it will require all items mentioned earlier for Bldg 136 condensate return plus:

- condensate pit
- condensate pump
- pit/pump controls
- piping from pit pump to boiler

RS&H

SUBJECT: ECO # 6 AEP NO

SHEET OF

DESIGNER: P. Hutchins DATE: 3/7/91

CHECKER DATE

- Determine condensate return requirements for donkey boiler from Bldg 35 plating areas

- Calculate condensate return pipe size

Ref.: "Flow of Fluids", Crane, 1979, p. 3-6,7

- Reasonable velocities are:

Boiler Feed	8 to 15 fps
General Service	4 to 10 fps

The steam flow is ~ 7000 lbs/hr

The water density @ 200F is 60.1 lbs/cf

$$7000 \frac{lbs}{hr} \cdot \frac{cf}{60.1\,lbs} \cdot \frac{hr}{3600\,sec} = \underline{\underline{0.032}} \frac{cf}{sec}$$

To keep the flow around 10 fps the pipe diameter should be

$$0.032 \frac{ft^3}{sec} \cdot \frac{7.5\,gal}{ft^3} \cdot \frac{60s}{min} = 14.4\,gpm$$

$$Q = VA$$
$$A = Q/V$$
$$A = \pi D^2/4$$
$$\pi D^2/2 = Q/V$$

$$D = \sqrt{\frac{4Q}{\pi V}} = \sqrt{\frac{4\left(0.032 \frac{cf}{sec}\right)}{3.14 * 10 \frac{ft}{sec}}}$$

$$= 0.064\,ft = 0.77 \text{ inches}$$

or

$\underline{\underline{3/4" \text{ pipe}}}$

- Calculate condensate return pump size using Bernoulli's Eqn.

$$H = 144\,\frac{P_2 - P_1}{\rho} + \frac{V_2^2 - V_1^2}{2g} + Z_2 - Z_1 + h_f$$

where
H = total head (ft)
P_1 = pressure at ① (psig)
P_2 = pressure at ② (psig)
ρ = density of water @ 200°F (lbs/cf)
$Z_{1,2}$ = elevations at ①, ②
h_f = friction loss (ft)

Pumping will be from the gun tube chrome plate area condensate tank to the pony boiler located due east of this area and outside of the building.

$P_1 = P_2$ = atmospheric pressure (pumping from one tank to another)

$V_1 = V_2 = 0$

$H = Z_2 - Z_1 + h_f$

$h_f = f\,\frac{L}{D}\,\frac{V^2}{2g}$

RS&H®

SUBJECT ECO#6 AEP NO

SHEET OF

DESIGNER DATE

CHECKER DATE

- Calculate f, friction factor

f is read from the Moody friction factor chart knowing the Reynolds number and ϵ/D

where $\epsilon = 0.0002$ for steel pipe

$$\epsilon/D = \frac{0.0002}{0.0687'} = 0.0029$$

$$N_{RE} = \frac{DV}{\nu} = \frac{0.0687\,ft \cdot 10\,ft/sec}{0.341E{-}5\,ft^2/sec} =$$

$$= 2.01E5$$

For $\epsilon/D = 0.0029$ and $N_{RE} = 2.01E5$, $f = 0.0265$

$$h_f = 0.0265 \frac{300\,ft}{0.0687\,ft} \frac{(10\,ft/sec)^2}{2\,(32.2\,ft/sec^2)}$$

$$h_f = 180 \text{ feet}$$

$$z_2 = -30 \text{ feet}$$

$$H = -30 + 180 = 150\,ft$$

$$bhp = \frac{QH}{3960\,\eta_p}$$

where Q = gal/min H = head in ft η_p = pump eff

$$= \frac{14.4 \cdot 150}{3960\,(0.7)} = 0.78\,hp$$ - use 1 hp pump

RS&H®

SUBJECT ECO #6 | AEP NO

DESIGNER | SHEET OF

CHECKER | DATE | DATE

for return from the small parts plating area

$$H = z_2 - z_1 + h_f$$

$$z_2 - z_1 = 0$$

$$h_f = f \frac{L}{D} \frac{V^2}{2g} = 0.0265 \frac{300}{0.0687} \frac{10^2}{2 \cdot 32.2}$$

$$h_f = 180 \text{ ft}$$

$$bhp = \frac{14.4 \cdot 180}{3960\ (.7)} = 0.9 \text{ hp} \quad \text{use } 1 \text{ hp pump}$$

Summary

Use 1" schedule 40 pipe - 600 ft
due to sensor requirements
and 2, 1 hp pumps

SUBJECT	ECO #6	AEP NO	
		SHEET	OF
DESIGNER		DATE	
CHECKER		DATE	

- Determine equipment requirements for returning condensate from Bldg 35 plating areas to the Main Boiler Plant

Since condensate from the steam space heating system is already returned, the only requirements will be piping from the proposed receivers for returning condensate to the donkey boiler

Include 100' of 3/4" pipe plus valves

- Summarize total system requirements

The schematic on the following page shows the proposed condensate return system. pH sensors are use to divert condensate to waste drain if pH falls below a preset level, indicating acid contamination from plating areas. Otherwise, condensate flows to Bldg 136 during heating season and Bldg 35 donkey boiler during non-heating times.

HERMAN GOLDNER COMPANY, INCORPORATED
SINCE 1887
7777 BREWSTER AVE., PHILADELPHIA, PA 19153
215-365-5400 FAX: 215-365-8550

QUOTATION

TO: REYNOLDS SMITH + HILLS
JACKSONVILLE, FL

ATTN MR PAUL HUTCHINS

DATE: 8/9/91

YOUR INQUIRY: CONDENSATE DIVERTING VALVES

GENTLEMEN:

WE HEREBY SUBMIT OUR QUOTATION WHICH IS SUBJECT TO IMMEDIATE ACCEPTANCE.

ITEM NO.	QUANTITY	DESCRIPTION	NET UNIT PRICE	TOTAL
		FOR CONDENSATE SERVICE AT 25 PSIG		
		+ 200°F.		
A	1	1" WORCESTER #D-446TTSEVI DIVERTING	$602.16	
		BALL VALVE, CS BODY, 1" NPT (F), 316 TRIM,		
		TEFLON SEATS + SEALS, Cv 10, ASSEMBLED WITH		
		RCS #MAR25-10-4 ELECTRIC ACTUATOR,		
		N7, 115VAC, 0.75AMP LOCKED ROTOR		
		DRAW, 2 EXTRA SWITCHES		
B	2	1" WORCESTER #D-446TTSEVI DIVERTING		
		BALL VALVE S/A ABOVE EXCEPT		
		WITH MANUAL LEVER 90°	123.70	

DELIVERY: 3 wks

F.O.B. PHILA

PRICES IN EFFECT AT TIME OF SHIPMENT WILL APPLY.

TERMS: ~~2% - 10TH AND 25TH~~ - NET 30 UNLESS OTHERWISE INDICATED

HERMAN GOLDNER CO., INC.

PER Brinkley

6-16

8-21

AUG-08-'91 THU 14:07 ID:OMEGA ENG. -ENG. TEL NO:203-359-7990 #642 P01

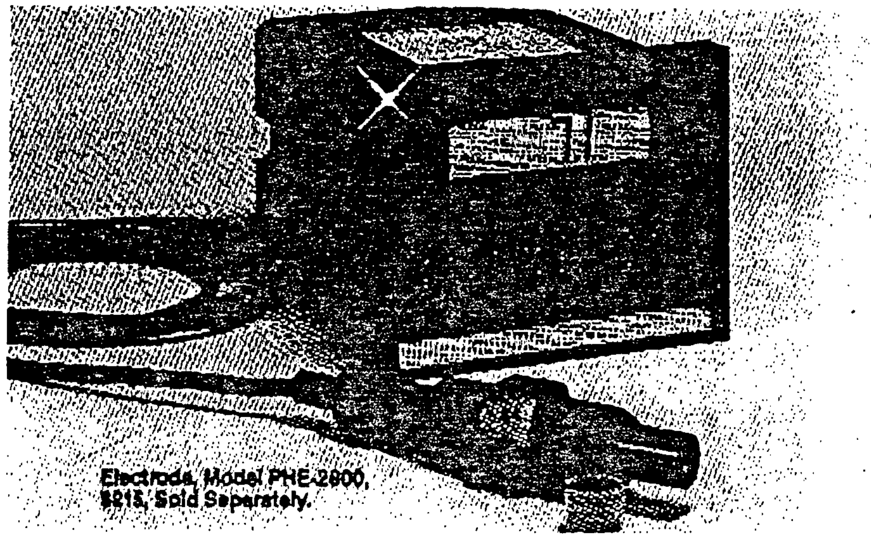
OMEGA
An OMEGA Technologies Company

SPEC SHEET
PHCN-28

Versatile Microprocessor-Based pH Controller

From
$625

- Compact NEMA-4X Polycarbonate Enclosure
- Two Independently Adjustable Alarm Contacts with Adjustable Deadband
- Choice of 4-20 mA dc or RS232C Output
- Auto Calibration, Dual Point or "Grab Sample"
- 10 Self Diagnostic Functions
- Direct or Reverse Analog Output with Span From 0.1 to 20 pH Units
- CSA Approved


Electrode, Model PHE-2800, $215, Sold Separately.

The OMEGA PHCN-28 microprocessor pH controller features auto buffering, solution temperature compensation, self-diagnostics and communication capabilities. Designed with the end-user in mind, this controller is user friendly and easy to operate. Four tactile membrane keypads allow for the selection and input of set-up parameters, input of calibration data and alarm setpoint adjustments. The two 5 A, 230 Vac relays can be configured as high/low, high/high or low/low.

The PHCN-28 is offered with a choice of an isolated 4-20 or 0-20 mA dc output (field selectable) or an RS232C interface with a non-isolated 0-5 V analog output. The analog output is flexible enough to be used as either a proportional control output or recorder output. The self-diagnostics of the PHCN-28 can alert the user to such conditions as internal circuitry malfunction, pH out of range, pH slope out of normal range, ATC short or open, or electrode failure to stabilize in buffer.

The PHCN-28 has an integral pre-amplifier and is designed for use with the PHE-2800 gel filled, double junction combination electrode with ATC. For locations where the electrode and controller must be separated by more than 50 ft, the PHCN-28-PA external pre-amplifier should be considered. The unit features a rugged NEMA-4X polycarbonate enclosure. If an application requires an electrode other than the PHE-2800, then the PHCN-28-PA must be used. In this case a Pt100 is necessary for ATC.

SPECIFICATIONS

Ranges: −4 to 16 pH, −100 to 200°C
Resolution: 0.01 pH, 0.1°C
Temperature Compensation: Automatic 0 to 100°C, Pt100 ohm RTD
pH Accuracy: ±0.02 pH over range, −4 to 16 pH
Temp Accuracy: ±0.25°C over 0 to 100°C
Stability: ±0.01 pH, ±1 mV ORP over 30 days non-cumulative
Sensitivity: ±0.01 pH, ±1 mV ORP
Repeatability: ±0.01 pH, ±1 mV ORP
Ambient Temperature Coefficient: ±0.002 pH/°C
Power Input: 120 V 50/60 Hz 8 Watts, 240 V 50/60 Hz 8 Watts, jumper selectable (requires fuse change)
Outputs: 4-20 mA dc isolated, RS232C with 0-5 V non-isolated
Output Span: Any 0.1 to 20 pH span (0.1 pH increments) selectable reverse or direct acting
Alarms: 2 SPST electromechanical relays rated 5 A 230 Vac, resistive load; supplied as normally open; alarms can be configured H/H, H/L, L/L; alarm deadband fully adjustable over pH span
Dimensions: 4.45"H × 5.75"W × 6.95"D (113 x 146 x 177 mm)
Weight: 3 lbs (1.35 kg)

1 YEAR WARRANTY — MADE IN USA — CSA

To Order (Specify Model No.)

Model No.	Price	Description
PHCN-28 (650	~~$625~~	pH controller w/isolated 4-20 or 0-20 mA dc output
PHCN-28-D	~~730~~ 760	pH controller w/RS232C interface and 0-5 V analog output (software available)
PHE-2800	~~215~~ ~~235~~ 250	Combination gel filled, double junction electrode w/ATC (integral Pt100); Kynar body construction; 1" MNPT connections at both ends for insertion or submersion, max pressure 100 PSIG at 65°C. Overall electrode length 5.87", insertion length 2.52"
PHCN-28-PA	~~319~~ 365	Pre-amplifier for distances >50 ft or for use w/electrodes other than PHE-2800; NEMA-4X enclosure (6.94" × 5.25" × 3.25")

OMEGACARE™ Extended Warranty: not available for this product.

OMEGA ENGINEERING, INC.
One Omega Drive, Box 4047, Stamford, CT 06907
Telex 996404 Cable OMEGA EASYLINK: 62968934
1-800-82-66342
1-800-TC OMEGA
In CT Dial (203) 359-1660
24 Hour FAX: (203) 359-7700

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: Watervliet Arsenal | PLANT: Boiler Plant | BLDG. NO.: 136 | MONTH: May -90

Day	STEAM PRODUCED #1 1000 LB	#2 1000 LB. (1)	#3 1,000 LB. (2)	#4 1,000 LB. (3)	#5 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. X (6)/666	#2+6 FUEL USED LB. M.C.F. GAL. oil (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. X 1000 (12)	%CO2 BOILER 1 (13)	#5 (14)	3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	2 °F. (17)	3 °F. (18)	FLUE TEMP 4 (19)	FLUE TEMP 5 (20)	MAKE UP % (21)	EFF. (22)	INIT. (23)
1	324.9				282.9	607.8	544	5209	15.4	63.3	6	230	42.2		2.7		353				480	38.8	81.8	RH
2	357.9				286.3	644.2	558	5518	15.4	55.5	6	230	41.0		2.8		352				480	36.7	81.9	RH
3	317.2				289.7	606.9	515	5187	15.4	53.6	6	230	38.0		2.8		353				479	36.9	82.0	HH
4	314.3				291.6	605.9	510	5272	15.0	54.9	6	230	40.1		2.7		357				483	40.0	80.2	HH
5	276.5				297.7	574.2	488	5092	14.7	57.2	6	230	34.3		2.6		353				480	35.1	78.3	HH
6	296.8				288.6	585.4	519	5305	14.5	50.6	6	230	37.4		2.8		346				470	36.0	77.1	HH
7	31.0	551.9			274.4	857.3	604	6153	16.8	50.9	6	230	43.5		2.6		360	417			480	36.0	89.8	HH
8		703.2				703.2	596	5555	15.6	53.7	6	230	40.5					430				34.0	83.3	HH
9		630.5				630.5	541	5004	15.6	68.2	6	230	42.1					407				38.9	83.9	HH
10		610.1				610.1	512	4862	15.5	65.6	6	230	41.5					400				70.5	82.6	RH
11		300.7				300.7	240	2317	16.0	51.9	6	230	19.2					410				40.0	85.4	RH
12																								
13																								
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TOTAL	715.4	2796.4			2011.2	6726.2	5627	*55474	169.9	615.4	66	2530	419.8		19		2474	2064			3352	412.9	905.3	
MAXIMUM	57.9	703.2			297.7	857.3	604	6153	16.8	68.2	6	230	43.5		2.8		360	430			483	40.5	89.8	
MINIMUM	31.0	300.7			274.4	300.7	240	2317	14.5	47.2	6	230	19.2		2.6		346	400			470	34.0	77.1	
AVERAGE	74.1	559.3			287.3	611.5	511.5	5043	15.4	55.9	6	230	38.2		2.7		353	413			479	37.5	82.3	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS * total includes 17,300 gal #2 oil and 38,174 gal. #6 oil

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY R. O. Drank | DATE 6/11/90 | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 2067

6-18

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION	PLANT	BLDG. NO.	MONTH
WATERVLIET ARSENAL	BOILER PLANT	35	JUNE 90

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 6 (1,000 LB.) (2)	STEAM PRODUCED BOILER 2 1,000 LB. (3)	STEAM PRODUCED BOILER 3 1,000 LB. (4)	STEAM PRODUCED TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. (6)	GAS FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	FW ~~OUTSIDE TEMP.~~ PUMP °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	FEEDWATER HEATER MAKEUP GAL. X100 (12)	%O2 BOILER 6 (13)	%O2 BOILER 2 (14)	%O2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 6 °F. (16)	FLUE GAS TEMPERATURE BOILER 2 °F. (17)	FLUE GAS TEMPERATURE BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	EFF (22)	INIT (23)
1	135	138.4			138.4		1701	17.3	278	6	230	21.2	4.7			363						92.3	JH
2	135	103.6			103.6		1321	16.6	280	6	230	15.9	6.0			360						88.5	RL
3	135	143.9			143.9		1800	17.0	270	6	230	20.5	4.3			[illegible]						[illegible]	RK
4	135	223.4			223.4		2666	17.8	278	6	230	29.8	3.3			371						94.9	RL
5	135	204.7			204.7		2447	17.8	280	6	230	28.7	4.0			365						94.9	RH
6	135	193.5			193.5		2332	17.7	280	6	230	27.2	4.7			370						94.3	PM
7	135	156.1			156.1		1901	17.5	280	6	230	15.9	4.4			363						93.3	RL
8	135	40.7			40.7		663	13.1	280	6	230	9.5	6.5			360						69.6	PM
9																							
10	135	75.4			75.4		1007	15.9	280	6	230	12.5	6.8			340						84.9	PM
11	135	174.4			174.4		2181	17.5	280	6	230	21.9	5.8			367						93.3	PM
12	135	169.3			169.3		2180	17.3	280	6	230	24.3	5.6			372						92.3	PM
13	135	169.2			169.2		2070	17.4	280	6	225	24.0	4.7			370						92.7	PM
14	135	190.0			190.0		2307	17.5	280	6	225	26.2	4.6			367						93.4	PM
15	135	86.4			86.4		1089	16.8	280	6	215	12.5	5.0			368						89.9	PM
16																							
17	135	92.0			92.0		1660	11.7	280	6	220	32.2	6.5			320						62.3	HH
18	135	167.0			167.0		2080	17.0	280	6	220	24.5	6.0			347						90.6	HH
19	125	169.3			169.3		2101	17.0	280	6	220	24.1	4.8			349						90.6	HH
20	135	171.4			171.4		2110	17.2	280	6	220	24.5	5.5			356						91.7	HH
21	135	189.2			189.2		2299	17.5	280	6	230	26.5	4.8			330						93.3	PK
22	135	71.2			71.2		939	16.1	280	6	230	12.7	5.7			360						85.9	PK
23																							
24	135	139.8			139.8		1752	16.9	280	6	230	19.4	4.0			360						90.4	PK
25	135	212.7			212.7		2558	17.7	280	6	230	30.8	4.6			370						94.3	PM
26	135	202.0			202.0		2434	17.2	280	6	230	30.3	4.0			368						94.1	JH
27	125	201.4			201.4		2446	17.5	282	6	230	30.4	4.7			367						93.4	JH
28	135	192.6			192.6		2328	17.6	277	6	230	29.0	4.3			368						93.8	JH
29	135	139.1			139.1		1745	12.0	283	6	230	22.3	6.0			340						90.4	JH
30	135	88.4			88.4		1251	15.0	285	6	230	15.3	6.4			355						91.2	RK
31																							
TOTAL	4050	4110.0			4110.0		51373	453.1	7553	162	6195	611.6	137.7			9695						2416.0	
MAXIMUM	135	223.4			223.4		2666	17.8	285	6	230	32.2	6.8			371						94.9	
MINIMUM	135	40.7			40.7		663	11.7	270	6	225	9.5	3.3			330						62.3	
AVERAGE	135	152.2			152.2		19027	16.8	279.7	6	229	22.6	5.1			359						89.5	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: R. O. Drank — DATE: 7/9/90

APPROVED BY — DATE

POST ENGINEER — DATE

DA FORM 2867

6-19

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO. 35 | MONTH: July 90

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 6 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. (6)	GAS FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	~~OUTSIDE TEMP.~~ FEED PUMP (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. X100 (12)	%O2 BOILER 6 (13)	%O2 BOILER 2 (14)	%O2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 6 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	EFF (22)	INIT (23)
1	135	115.9			115.9		1591	15.5	285	8	230	18.7	7.7			350						82.6	RH
2	135	153.3			153.3		1881	17.3	283	8	230	22.7	6.3			360						92.2	RH
3	135	102.0			102.0		1346	16.1	280	8	230	15.5	6.2			357						86.0	RH
4	135	126.9			126.9		1716	15.7	280	8	230	15.3	6.2			355						83.7	PK
5	135	178.3			178.3		2185	17.4	280	8	230	26.8	5.6			368						92.8	RH
6	135	88.7			88.7		1082	17.4	280	8	230	12.3	5.9			365						93.0	PK
7																							
8	135	130.0			130.0		1557	12.7	280	8	230	15.9	3.7			370						92.7	PK
9	135	135.1			135.1		1705	16.8	280	8	230	19.0	6.1			365						89.5	PK
10	135	129.7			129.7		1645	16.7	280	8	230	18.6	6.8			365						89.4	PK
11	135	166.0			166.0		2051	17.2	280	8	230	27.0	6.0			360						91.8	PK
12	135	172.3			172.3		2115	17.3	280	8	230	26.6	6.2			365						92.4	PK
13	135	146.8			146.8		1789	17.5	285	8	230	23.4	6.5			365						93.1	PK
14	135	152.6			152.6		1903	17.1	280	8	230	23.1	6.0			365						91.1	HH
15	135	140.7			140.7		1781	16.8	280	8	230	16.8	6.0			365						89.5	HH
16	135	165.1			165.1		2055	17.0	300	8	230	21.8	6.0			365						90.6	HH
17	135	165.3			165.3		2053	17.0	300	8	230	25.7	5.5			365						90.6	PK
18	135	156.9			156.9		1965	17.0	293	8	230	25.5	5.6			373						90.6	JH
19	135	123.4			123.4		1597	16.4	290	8	230	21.7	5.8			358						87.7	JH
20	135	22.9			22.9		477	17.4	290	8	230	8.3	7.2			355						92.7	[illegible]
21	—	Shut down —																					
22																							
23																							
24																							
25																							
26																							
27																							
28																							
29																							
30																							
31																							
TOTAL		2571.9			2571.9		[illegible]	321.3	5406			384.7	115.3			6891						1720	
MAXIMUM		178.3			178.3		2185	17.7	300	8	230	27.0	7.7			373						93.1	
MINIMUM		22.9			22.9		1346	15.5	280	8	230	8.3	3.7			350						82.6	
AVERAGE		[illegible]			[illegible]		17.0	16.9	285	8	[illegible]	20.2	6.1			363						[illegible]	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: R.D. Brank | DATE: 8/6/90 | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

6-20

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*
For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: Watervliet Arsenal | PLANT: Boiler Plant | BLDG. NO. 35 | MONTH: Aug 90

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER #6 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. (6)	GAS FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	~~OUTSIDE~~ TEMP. AV. FEED °F (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%CO2 BOILER 6 (13)	BOILER 2 (14)	BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 6 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	EFF (22)	INIT (23)
1																							
2					SHUT DOWN																		
3																							
4	135	123.5			123.5		1010	16.8	290	8	230	21.2	5.0			360						89.9	DK
5	135	114.2			114.2		1170	16.8	290	8	220	16.3	7.0			360						89.9	[illegible]
6	135	159.8			159.8		2155	17.0	270	8	220	24.4	5.6			360						90.6	[illegible]
7	135	139.5			139.5		1760	16.8	280	8	220	22.3	6.0			356						89.9	[illegible]
8	135	157.1			157.1		1940	17.3	275	8	230	24.3	4.6			362						91.5	[illegible]
9	135	167.1			167.1		2066	17.3	280	8	230	27.3	6.0			367						91.7	[illegible]
10	135	53.6			53.6		765	14.5	280	8	220	11.3	7.5			361						77.3	[illegible]
11	SHUT DOWN																						
12	135	109.1			109.1		1296	17.8	300	8	230	15.0	6.0			360						94.9	[illegible]
13	135	160.5			160.5		2003	16.9	293	8	230	25.3	5.5			362						90.1	[illegible]
14	135	116.5			116.5		1549	15.8	300	8	220	31.6	5.8			360						84.2	[illegible]
15	135	164.1			164.1		2020	17.3	263	8	230	25.8	5.1			362						90.6	[illegible]
16	135	161.7			161.7		2000	17.3	260	8	230	35.6	5.0			360						91.7	[illegible]
17	135	[illegible]			[illegible]		969	16.7	367	8	230	13.0	5.5			360						89.1	[illegible]
18	SHUT DOWN																						
19	135	106.9			106.9		1329	17.1	300	8	230	16.3	4.6			360						91.1	PK
20	135	176.3			176.3		2152	17.4	290	8	230	27.9	4.6			366						92.7	PK
21	135	205.5			205.5		2483	17.6	290	8	230	31.5	5.0			366						93.8	PK
22	135	187.6			187.6		2280	17.5	290	8	230	19.1	4.9			365						93.3	PK
23	135	160.2			160.2		1999	17.0	290	8	230	26.5	5.1			365						90.6	PK
24	135	98.0			[illegible]		1203	17.1	250	8	230	16.5	4.2			362						[illegible]	[illegible]
25	SHUT DOWN																						
26	135	190.5			190.5		2590	[illegible]	220	8	230	11.8	4.3			361						[illegible]	[illegible]
27	135	174.3			174.3		2167	17.1	—	[illegible]	230	37.2	5.5			362°						91.1	PK
28	135	183.6			183.6		2292	17.0	230	8	230	29.1	4.7			357°						90.6	PK
29	135	191.3			191.3		2353	17.2	255	8	230	29.7	4.3			365°						91.7	PK
30	135	171.9			171.9		2239	16.3	250	8	230	28.6	4.5			362°						86.9	PK
31	135	138.4			139.4		1720	17.1	250	8	233	22.6	5.0			362°						91.1	PK
TOTAL		3676.6			3676.6		46329	421.7	6933			599.9	131.3			9147						[illegible]	
MAXIMUM		205.5			205.5		2590	17.8	367	8	233	37.2	7.0			367						94.9	
MINIMUM		53.6			53.6		765	14.5	220	8	220	11.2	4.2			356						77.3	
AVERAGE		147.1			147.1		1853	16.9	277	8	[illegible]	24.0	5.3			362						[illegible]	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: R. D. Krank | DATE: 9/5/90 | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98 1 JUN 58, WHICH WILL BE USED.

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 35 | MONTH: SEPT. 90

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER 6 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. (6)	GAS FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	FEED OUTSIDE TEMP AV. PRESS °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. (12)	%O2 BOILER 6 (13)	BOILER 2 (14)	BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 6 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	EFF (22)	INIT (23)
									260	8	230	25.3	3.4			375						68.6	PK
1	135	29.7			29.7		491															93.3	PK
2							1376		250	8	230	25.3	41			375						89.3	
3	135	113.2			113.2		1792		250	8	230	24.9	1.3			362°						87.3	
4	135	142.0			142.0		1436		250	8	230	19.7	5.2			357°						91.7	
5	135	110.6			110.6		2063		250	8	230	23.9	5			362						93.7	
6	135	166.9			166.9		1466		250	8	230	19.1	6			362°						63.9	H.H.
7	135	108.3			108.3		752		250	8	230	11.1	8			325						94.3	H.H.
8	135	42.6			42.6		[illegible]		250	8	230	15.9	6.5			366						93.2	H.H.
9	135	[illegible]			[illegible]		2306		250	8	230	27.7	5.0			363						[illegible]	H.H.
10	135	180.3			180.3		2155		250	8	230	35.1	4.5			366						93.3	H.H.
11	135	176.3			176.3		2179		250	8	230	22.2	4.5			363						93.3	H.H.
12	135	178.2			178.2		2075		250	8	230	26.5	4.5			361						[illegible]	[illegible]
13	135	168.7			168.7		1533		250	8	[illegible]	[illegible]	[illegible]			361							
14	135	91.6			91.6																	44.2	JH
15							1424		270	8	230	16.5	5.3			360						91.6	JH
16	135	118.2			118.2		1875		250	8	230	35.0	5.2			362						92.2	JH
17	135	151.5			151.5		1888		253	8	230	24.9	4.5			363						91.5	JH
18	135	153.4			153.4		1915		253	8	230	25.0	4.6			367						91.8	JH
19	135	154.5			154.5		1943		250	8	230	25.3	4.2			368						92.3	JH
20	135	157.2			157.2		2181		250	8	230	28.0	4.5			363						97.7	PK
21	135	177.5			177.5		1800		250	8	230	15.3	4.5			362°						90.3	PK
22	135	143.2			143.2		1861		250	8	230	16.9	4.5			360						89.6	PK
23	135	148.3			1483		1755		250	8	230	16.8	4.5			362						90.4	PK
24	135	138.8			138.8		1940		250	8	230	16.9	4.5			362						91.5	PK
25	135	154.8			154.8		2060		250	8	230	17.1	3.9			365						92.6	PK
26	135	166.3			166.3		2201		250	8	230	17.3	3.5			365						92.2	RH
27	135	179.8			179.8		2172		250	8	230	28.1	3.5			363						92.6	RH
28	135	176.9			176.9		2178		253	8	230	31.6	4.5			368						92.7	PK
29	135	177.8			177.8		2155		250	8	230	24.4	6			360°							
30	135	178.7			178.7																		
31									7039			617.3	130.4			10137						2497.2	
TOTAL		39835			39835		49696		270			31.6	8			368						93.3	
MAXIMUM		180.3			180.3		2206		250			11.1	3.4			325						68.6	
MINIMUM		29.7			29.7		491		251			220	4.6			362						89.2	
AVERAGE		142.2			142.2		1775																

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

PREPARED BY: R. Drank | DATE: 10/5/90 | APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 2067 REPLACES DA FORM 5-88, 1 JUN 58, WHICH WILL BE USED.

6-22

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: Boiler Plant | BLDG. NO. T35 | MONTH: OCT. 90

DATE	STEAM PRESSURE LB. (1)	STEAM PRODUCED BOILER X6 1,000 LB. (2)	BOILER 2 1,000 LB. (3)	BOILER 3 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. (6)	GAS FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. FEED PUMP (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	FEEDWATER HEATER MAKEUP GAL. X1000 (12)	%CO2 BOILER 6 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 6 °F. (16)	FLUE GAS BOILER 2 °F. (17)	FLUE GAS BOILER 3 °F. (18)	TEMP. H.W. SUPPLY °F. (19)	TUBES CLEANED NUMBER OF TIMES (20)	PREVENT MAINT. CHECK (21)	EFF. (22)	INIT. (23)
1	135	173.2			173.2		2156	17.0	250	8	230°	26.6	4.0			368						91.1	PK
2	135	256.6			256.6		3083	17.7	250	8	230°	37.1	4.0			370						93.3	PC
3	135	183.5			183.5		2254	17.3	250	8	230°	28.8	4.2			369						92.3	PV
4	[illegible]	115.5			[illegible]		[illegible]	[illegible]	250	8	230	[illegible]	[illegible]			[illegible]						[illegible]	[illegible]
5	125	[illegible]			[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	230	[illegible]	[illegible]			[illegible]						[illegible]	[illegible]
6																							
7																							
8	125	[illegible]			[illegible]		[illegible]	18.5	[illegible]	8	230	[illegible]	[illegible]			[illegible]						98.6	[illegible]
9	[illegible]	[illegible]			195.3		2149	18.3	250	8	230	29.5	4.1			375						97.5	[illegible]
10	125	[illegible]			[illegible]		[illegible]	[illegible]	250	8	230	[illegible]	4.0			[illegible]						95.0	[illegible]
11	12.5	225.7			225.7		2967	[illegible]	250	8	230	[illegible]	[illegible]			[illegible]						[illegible]	[illegible]
12	125	186.2			186.2		2291	17.2	250	8	230	[illegible]	[illegible]			[illegible]						[illegible]	[illegible]
13	125	[illegible]			[illegible]		11.31	16.7	[illegible]	8	230	22.9	5.0			360						[illegible]	[illegible]
14	[illegible]	189.9			[illegible]		[illegible]	17.3	250	8	230	[illegible]	[illegible]			[illegible]						[illegible]	[illegible]
15	12.5	271.8			271.0		2233	177	250	8	230	[illegible]	[illegible]			[illegible]						[illegible]	[illegible]
16	125	[illegible]			[illegible]		2734	[illegible]	250	8	230	45.1	3.0			[illegible]						95.6	[illegible]
17	125	269.7			[illegible]		3345	[illegible]	250	8	230	41.8	3.7			375						93.9	[illegible]
18																							
19																							
20																							
21																							
22																							
23																							
24																							
25																							
26																							
27																							
28																							
29																							
30																							
31																							
TOTAL		[illegible]			31550		37790	[illegible]	[illegible]	120	3450	470.4	[illegible]			[illegible]						1479.[illegible]	
MAXIMUM		324.4			324.4		3724	18.5	250	8	230	45.2	5.1			376						98.6	
MINIMUM		32.7			32.7		377	16.6	250	8	230	6.0	3.0			358						88.5	
AVERAGE		210.3			210.3		2519	17.7	250	9	230	31.4	4.2			368						93.9	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: R. D. Trank | DATE: 11/16/90 | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967, 1 NOV 72 — REPLACES DA FORM 5-98, 1 JUN 58, WHICH WILL BE USED.

6-23

- Calculate current energy use for the cooling tower fans in the gun tube chrome plating area

There are two cells, each with 40 hp centrifugal, forward-curve fans. One cell fan handles the load for all but the hottest days. The fan operates continuously at a constant speed, five days per week, 50 weeks per year. Assume the fan load is 85% of capacity.

$$E = 40\,hp \times \frac{0.746\,kW}{hp} \cdot \frac{5\,da}{wk} \cdot \frac{24\,hr}{da} \cdot \frac{50\,wk}{yr} \cdot \frac{3413\,Btu}{kWh} \cdot 0.85$$

$$= \underline{\underline{519}}\ \frac{MBtu}{yr}\ \text{electricity}$$

- Calculate reduced energy use due to installation of variable speed drive and controls.

The diagram on the following page describes the glycol cooling system operation.

The calculation table following the diagram shows an energy use of 112 MBtu/yr using the VSD. The equation used for calculations are based on fan laws: $\frac{hp_2}{hp_1} = \left(\frac{Q_2}{Q_1}\right)^3$

RS&H®

SUBJECT ECO #7 LEAD

AEP NO

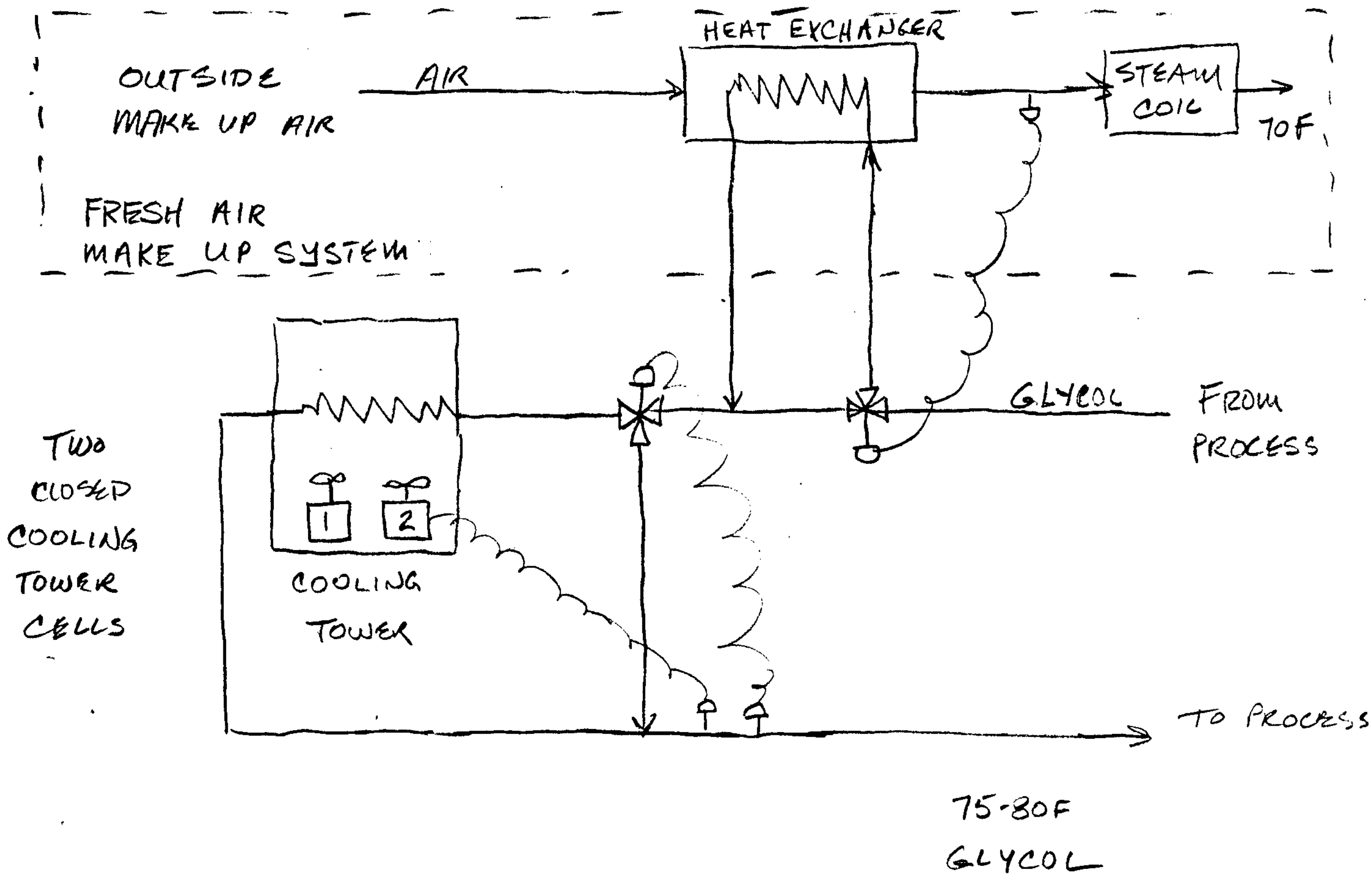
SHEET OF

DESIGNER P. Hutchins

DATE 8/5/91

CHECKER

DATE



- GLYCOL IS DIVERTED TO THE FRESH AIR MAKE UP SYSTEM DURING THE HEATING SEASON
- ONE COOLING TOWER FAN OPERATES CONTINUOUSLY
- THE SECOND OPERATES ONLY WHEN THE RETURN GLYCOL TEMPERATURE EXCEEDS THE SETPOINT
- PIT EXHAUST AND FUME EXHAUST FAN MOTORS ARE 100 Hp each

WATERVLIET ARSENAL LIMITED ENERGY STUDY
Cooling Tower Variable Speed Drive Energy Calculation
Operation Hrs/Day = 24

Hour Fractions	1 AM - 9 AM	1
	9 AM - 5 PM	1
	5 PM - 1 AM	1
Operation Days Per Week		7

1	2	3	4	5	6	7	8	9	10	11
	Temp. Range	Hours of Occurrence 2-9	10-17	18-1	Total Hours	Percent Full Load CFM Required	hp Required	kW	kBtu/hr	MBtu
95	99	0	7	0	7	110	53.2	39.7	135.6	0.9
90	94	0	28	6	34	105	46.3	34.5	117.9	4.0
85	89	0	95	28	123	100	40.0	29.8	101.8	12.5
80	84	4	177	73	254	95	34.3	25.6	87.3	22.2
75	79	27	248	140	415	90	29.2	21.8	74.2	30.8
70	74	115	257	222	594	85	24.6	18.3	62.5	37.2
65	69	234	235	271	740	75	16.9	12.6	43.0	31.8
60	64	263	212	252	727	65	11.0	8.2	28.0	20.3
55	59	274	190	236	700	55	6.7	5.0	16.9	11.9
50	54	263	183	214	660	45	3.6	2.7	9.3	6.1
45	49	242	183	205	630	35	1.7	1.3	4.4	2.8
40	44	229	202	205	636	25	0.6	0.5	1.6	1.0
35	39	261	241	251	753	20	0.3	0.2	0.8	0.6
30	34	295	220	262	777	10	0.0	0.0	0.1	0.1
25	29	216	156	191	563	0	0.0	0.0	0.0	0.0
20	24	163	112	130	405	0	0.0	0.0	0.0	0.0
15	19	110	79	96	285	0	0.0	0.0	0.0	0.0
10	14	84	43	65	192	0	0.0	0.0	0.0	0.0
5	9	60	27	38	125	0	0.0	0.0	0.0	0.0
0	4	37	16	22	75	0	0.0	0.0	0.0	0.0
-5	-1	27	3	9	39	0	0.0	0.0	0.0	0.0
-10	-6	10	0	4	14	0	0.0	0.0	0.0	0.0
-15	-11	5	0	0	5	0	0.0	0.0	0.0	0.0
-20	-16	3	0	0	3	0	0.0	0.0	0.0	0.0
Totals		2922	2914	2920	8756					112

Total adjusted for work week 112

RS&H	SUBJECT Eco #7	AEP NO	
	LEAD	SHEET	OF
	DESIGNER	DATE	
	CHECKER	DATE	

- Columns 1 through 5 are weather data from Engineering Weather Data, TM 5-785 for Albany, N.Y.
- Column 6 = 3 + 4 + 5
- 7 is based on engineering judgment
- 8 $= (7)^3 * 40$ hp
- 9 = 8 * 0.746 kw/hp
- 10 = 9 * 3413 Btu/kw ÷ 1E6
- 11 = 10 * 6

	MBtu/yr	
Energy savings ⇒	519	Current method
	- 112	New method
	407 MBtu/yr	electricity

There are three gun tube plating areas. One is to be removed.

Total savings = 407 * 2 = 814 MBtu/yr ELEC.

RS&H®

SUBJECT ECO #7
QRIP Calc's
DESIGNER Hutchins
CHECKER

AEP NO 290-0379-002
SHEET ____ OF ____
DATE 3/20/92
DATE

QRIP CALCULATIONS

PRESENT METHOD

519 MBTU/yr * 2 towers * $20.35 /MBTU = $21, 123

PROPOSED METHOD

.112 * 2 * 20.35 = 4558

SAVINGS

$16,565

RS&H

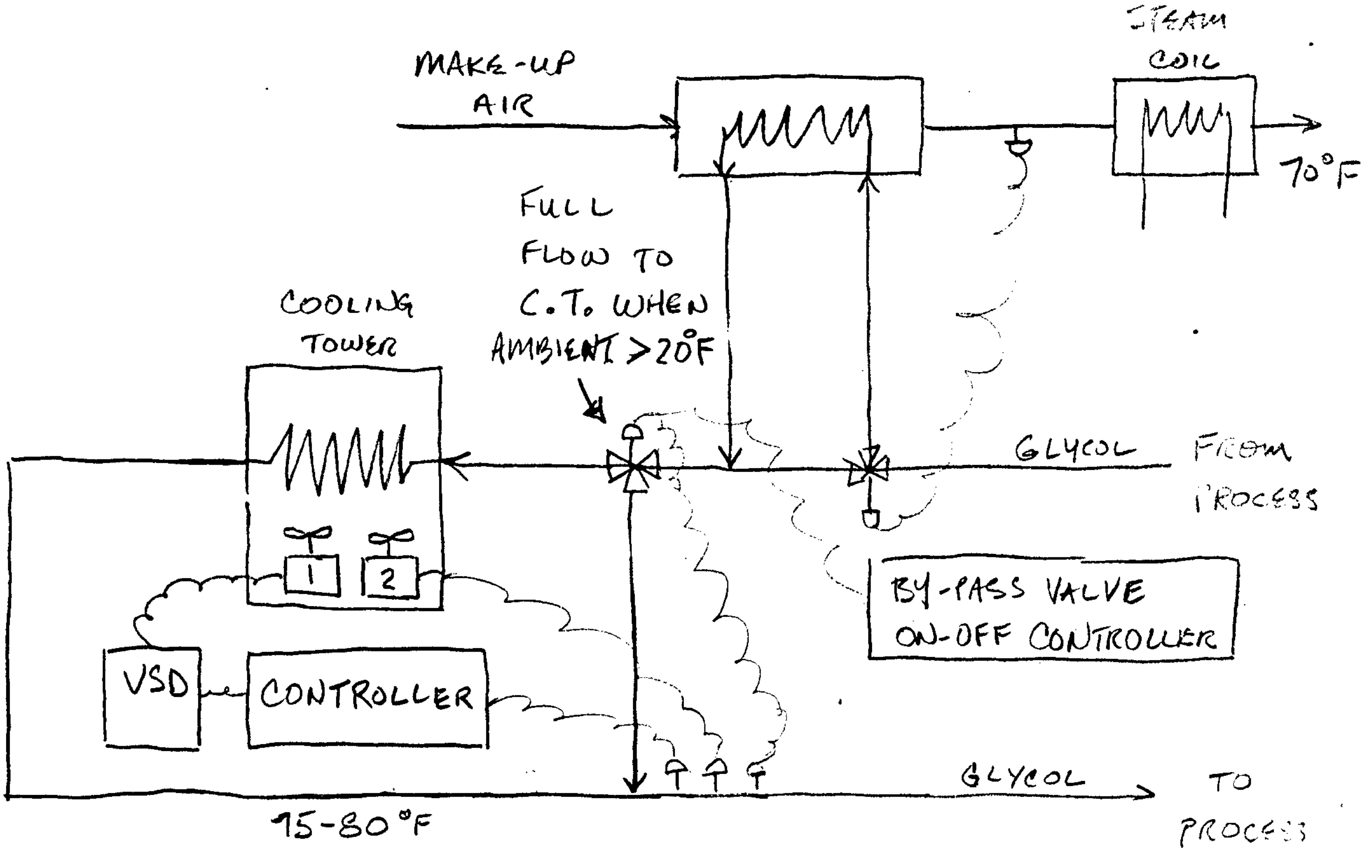
SUBJECT ECO #7 AEP NO

LEAD SHEET OF

DESIGNER DATE

CHECKER DATE

PROPOSED ADDITION OF VARIABLE SPEED DRIVE



- FOR ALL EXCEPT THE COLDEST DAYS THE BY-PASS 3-WAY VALVE IS INOPERATIVE, ALLOWING FULL FLOW TO THE COOLING TOWER. IN THIS MODE THE VSD MODULATES THE FAN SPEED TO MAINTAIN THE LEAVING GLYCOL TEMPERATURE.

- WHEN THE AMBIENT TEMP. IS LESS THAN, SAY 20°F, OR OTHER VALUE DETERMINED IN ACTUAL OPERATION, THE GLYCOL LEAVING TEMPERATURE IS CONTROLLED BY THE BYPASS VALVE. IN THIS MODE THE COOLING TOWER FANS ARE INOPERATIVE.

03/20/92

ECO Construction Cost Estimate Calculations

ECO Name: COOLING TOWER VARIABLE SPEED DRIVE

ECO #: 7

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$15,300
Labor		$1,650
	Subtotal bare costs	$16,950
FICA Insurance (20% of Labor)		$330
Sales Tax (not applicable for GOGO)		$0
	Subtotal	$17,280
Overhead (15%)		$2,592
	Subtotal	$19,872
Profit (10%)		$1,987
	Subtotal	$21,859
Bond (1%)		$219
	Subtotal	$22,078
Contingency (10%)		$2,208
Subtotal (Construction Cost Input For LCCID *)		$24,286
SIOH (6.0% of Construction Cost)		$1,457
	Subtotal	$25,743
Design (6% of Construction Cost)		$1,457
Total Project Cost		$27,200

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED 8/9/91

SHEET OF

PROJECT ENERGY ENGINEERING ANALYSIS

LOCATION WATERVLIET ARSENAL

ARCHITECT ENGINEER REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. COOLING TOWER FAN MOTOR VSD

ESTIMATOR P. HUTCHINS

CHECKED BY

ECO #7 SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
VAR. SPEED DRIVE - 40hp	1	ea	400	400	6400	6400	6800
PID CONTROLLER	1	ea	100	100	400	400	500
Type T Thermocouple	2	ea	25	50	50	100	150
Type T thermocouple wiring	1	cf	25	25	50	50	75
ON-OFF CONTROLLER	1	ea	100	100	400	400	500
Solid State Relays	2	ea	25	50	50	100	150
Miscellaneous - wiring, connectors, piping T's	1	ea	100	100	200	200	300
BARE COSTS TOTALS				825		7650	8475
FOR 2 UNITS				1650		15300	16960

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—510140

RS&H

Telephone Call Confirmation

(904) 389-0481

Project No. 290-0379-002

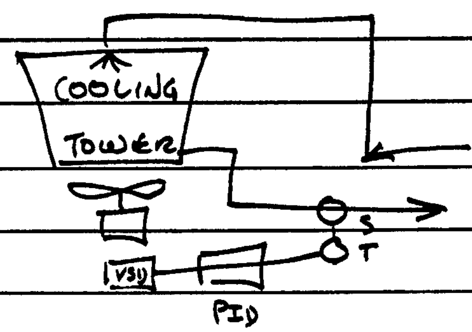
Local ✓ L.D. ____ Placed ✓ Rec'd. ____ Date 7/8/91

P. Hutchins Conversed With Wes Shaver

Of Shaver & Assoc. (Balt. Coil Rep.) Regarding Cooling Tower Motor VSD

VSD requires

- Sensor
- transmitter
- PID (Proportional Integral Derivative) Controller



Cost of VSD for 40 hp fan motor - $6400
includes bypass to use in conjunction with existing starter

Distribution:

3/89

RS&H

Telephone Call Confirmation

(203) 359-1660

Project No. 290-0379-002

Local ____ L.D. ✓ Placed ✓ Rec'd. ____ Date 8/14/91

P. Hutchins Conversed With Tom

Of Omega Regarding VSD Controller

- Tom recommends the CN2001 T-F1 Programmable Controller - $395 with a type T thermocouple, 4-20 ma output
- Type T thermocouple - $50
- Type T thermocouple wiring - $50

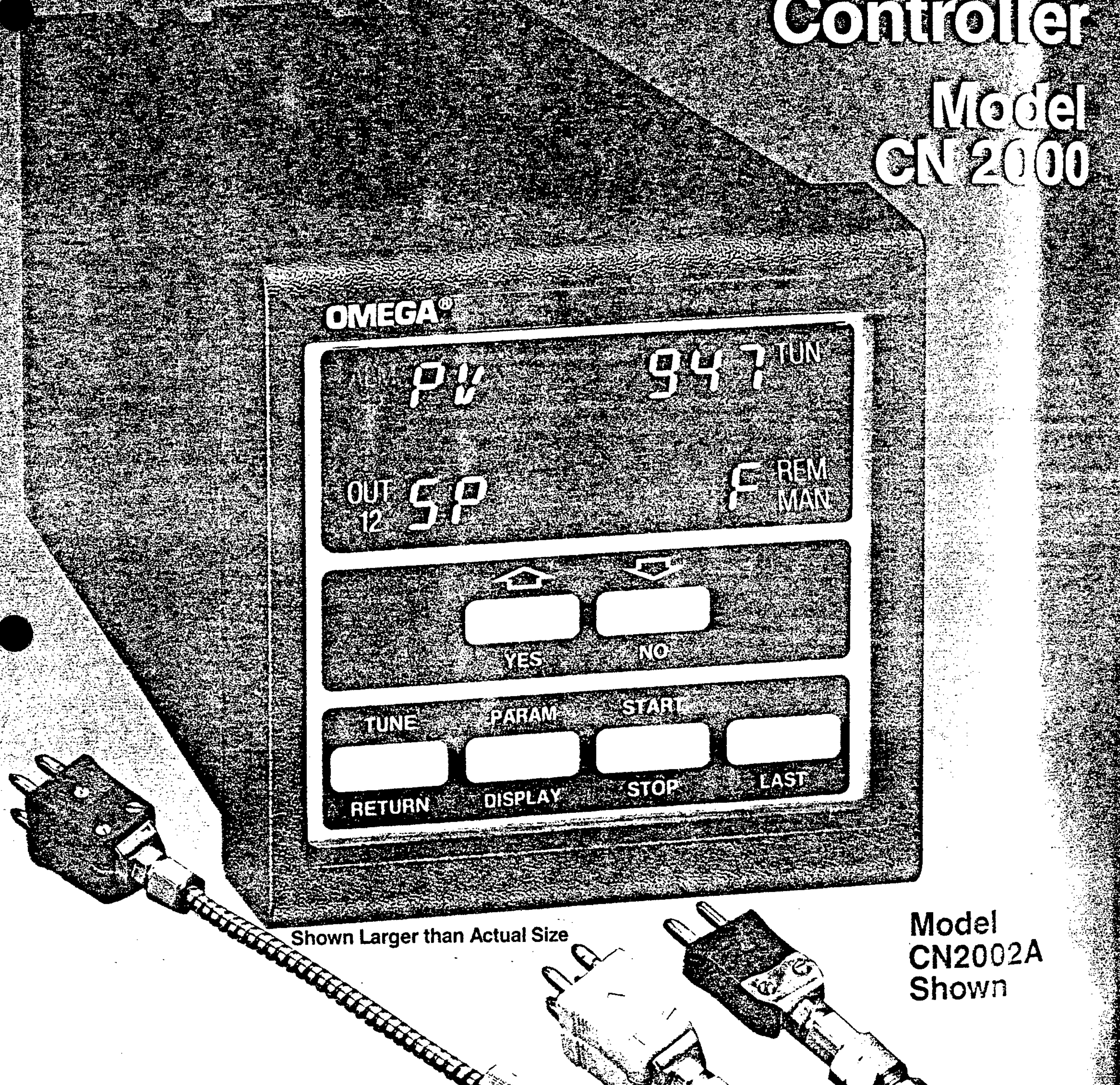
Distribution:

7-9

3/89

Temperature/Process Controller

Model CN 2000



Shown Larger than Actual Size

Model CN2002A Shown

Reliable and Accurate Microprocessor-Based Control

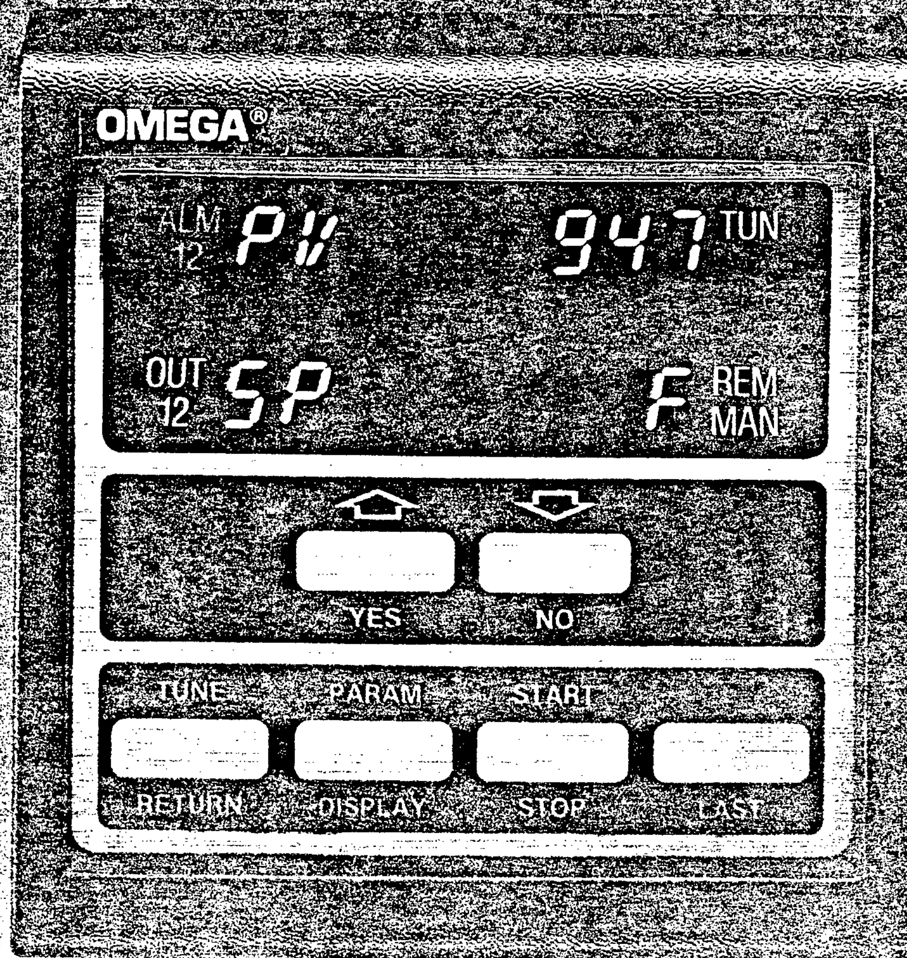
- For Thermocouple, RTD, Voltage and Current Inputs
- RS-232 and RS-422 Communication for Remote Control through a Computer System
- Wide Variety of Output and Alarm Options Available

For Use With

- ✓ Plastics Processing
- ✓ Heat Treating Furnaces
- ✓ Environmental Chambers
- ✓ Laboratories
- ✓ Food Processing
- ✓ Chemical Processing

See Section A for Industrial Thermocouple Probes

Microprocessor Accuracy



Prices Start At

$470

Includes Complete Manual

Shown Larger than Actual Size

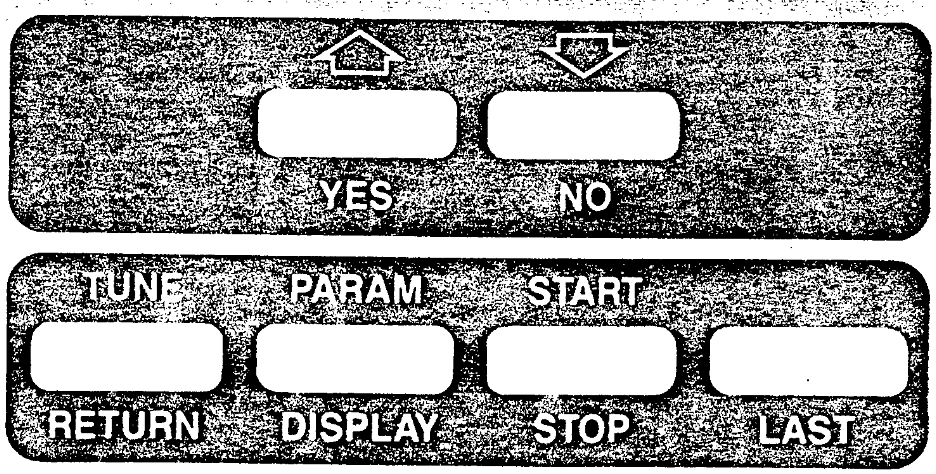
Features

- PID Control
- User Friendly Tuning Via Front Keypad
- Continuous Indication of Output, Alarm, and Operating Status
- 0.1° Resolution for RTD Inputs

The OMEGA CN 2000 microprocessor based controllers utilize the latest technology to improve reliability, accuracy, and control. Inputs can be either thermocouple with 1° resolution, RTD with either 1° or 0.1° resolution, and current or voltage with a scalable display. For the analog inputs, the display is scalable for zero and span over the entire ±3200 count range. CN 2000 controllers can be used with pressure and flow transducers, or with virtually any process transducer.

The CN 2000 controllers feature full 3-mode Proportioning, Integral (reset), Derivative (rate) control (PID). A unique multicolored display with vacuum fluorescent alphanumeric characters allow for easy, user friendly tuning with continuous indication of output, alarm, and operating status. The environmentally sealed touch panel is the operator interface to the CN 2000 and the precision, fine ning controls allow accurate adjustment of process parameters. The versatility of this controller makes it ideal for both laboratory and industrial uses.

Key Functions: Front Keypad is the operator interface. There are no internal pots, switches, or jumpers to set or adjust. Security key codes are required to access certain programs.



TUNE-RETURN
Calls up TUNE routine. Also RETURN program to normal operation

UP-YES
Drives set point to increase in value. Positive response to displayed question.

DISPLAY PARAM
Advances display in programmed sequence.

DOWN-NO
Drives set point to decrease in value. Negative response to displayed question.

START-STOP
Shuts off or turns on outputs. Not a power switch.

LAST
Recalls previous step to display. A backup key.

P

7-11

RS&H

SUBJECT: ENERGY-EFFICIENT FLUORESCENT LAMPS/BALLASTS
DESIGNER: C. WARREN
CHECKER:

AEP NO: 290-0379-002
SHEET: 1 OF
DATE: 3/26/92
DATE:

ECO 8 —

REPLACEMENT OF STANDARD FLUORESCENT LAMPS AND/OR BALLASTS WITH ENERGY-EFFICIENT TYPES

1/ SURVEY OF BUILDINGS ON WVA TABULATED IN TABLES 8-1 and 8-2, SHOWING TYPES OF FLUORESCENT LAMPS, NUMBERS OF LAMPS AND FIXTURES; WATTS AND KWH/YR, respectively.

ASSUMPTIONS - PRODUCTION AREAS ENERGIZE LIGHTS
24 HRS/DAY × 5 DAYS/WK × 50 WKS/YR

= 6000 HRS/YR

NON-PRODUCTION AREAS

11 HRS/DAY × 5 DAYS/WK × 50 WKS/YR

= 2,750 HRS/YR

STANDARD FIXTURE POWER DRAWS TAKEN FROM LIGHTING TEXTS — SURVEY NOTES CONTAIN DATA FOR EACH BUILDING THAT IS SUMMARIZED IN TABLES 8-1, 8-2.

2/ PREDOMINANT TYPES

F40T12 = 1,134,612/6,140,625 KWH/YR = 18.5%

F96T12 = 3,528,527/6,140,625 KWH/YR = 57.5%

F90T12 = 1,156,800/6140,625 KWH/YR = 18.8%

RS&H®

SUBJECT ENERGY LAMPS/BALLASTS
DESIGNER C. WARREN
CHECKER
AEP NO 290-0379-002
SHEET 2 OF
DATE 3/26/92
DATE

CONSIDER F40T12 & F96T12 FOR REPLACEMENT - F90T12 IS REPLACEMENT FOR F90T17 AND IS ENERGY-EFFICIENT.

REPLACEMENTS FOR F40T12 LAMPS
1. 34 W
2. 32 W T-8 SYSTEM - REQUIRES ELECTRONIC BALLAST

BALLASTS FOR F40
1. ENERGY ELECTROMAGNETIC
2. ELECTRONIC

REPLACEMENTS FOR F96T12 LAMPS
1. 60 W

BALLASTS - ELECTRONIC

SPECIFICATIONS AND PRICES TABLES 8-3 AND 8-4, resp.

3/ PERFORM CALCULATIONS TO DETERMINE INPUT DATA FOR LCCID CALCULATIONS

CASES CONSIDERED -

8 A. REPLACE 40-W LAMPS IN PRODUCTION AREAS WITH 34W LAMPS
LAMPS 308 (TABLE 8-1) 300 IN 100 FIXTURES
8 IN 4 FIXTURES

EXISTING 3-TUBE FIXTURES DRAW 144 W / FIXTURE
" 2-TUBE FIXTURES DRAW 96 W / FIXTURE

REPLACING W/ 34 WATT TUBES — 15.9% DROP IN LUMENS

144 W/FIX ⇒ 120 W/FIX
96 W/FIX ⇒ 80 W/FIX

RS&H®

SUBJECT ENERGY LAMPS/BALLASTS AEP NO 290-0379-002
SHEET 3 OF
DESIGNER C. WARREN DATE 3/26/92
CHECKER DATE

8B. SAME AS A; REPLACE BALLASTS WITH ENERGY-EFFICIENT ELECTROMAGNETIC BALLASTS
1 BALLAST / 2 LAMPS (WVA ELECT. DEPT.)
152 BALLASTS

3-TUBE FIXTURES FROM 144 W/FIX ⇒ 95 W/FIX
2-TUBE FIXTURES FROM 96 W/FIX ⇒ 66 W/FIX

8C. REPLACE 40 W LAMPS & BALLASTS WITH F40T8 LAMPS (32 W) and ELECTRONIC BALLASTS ⇒ 7.9% DROP IN LUMENS FROM EXISTING
3 TUBE FIXTURES USE 1 BALLAST/FIXTURE
DRAW: 88 W/FIXTURE
2 TUBE FIXTURES/1 BALLAST
DRAW 58 W/FIXTURE

8D. SAME AS A; MIXTURE OF 2, 3, 4 TUBE FIXTURES
ALL USE 1 BALLAST/2 TUBES - NON PRODUCTION BLDGS

8E. SAME AS B; NON-PRODUCTION BLDGS

8F. SAME AS C, except 1 BALLAST/2 LAMPS; NON-PRODUCTION BLDGS

8G. REPLACE 75 W F96T12 LAMPS WITH 60 W F96T12 LAMPS
PRODUCTION BUILDINGS ⇒ 10.6% DROP IN LUMENS
175 W/FIXTURE ⇒ 163 W/FIXTURE

8H. SAME AS G, WITH BALLAST REPLACEMENT (ELECTRONIC)
1 BALLAST / 2 LAMPS
175 W/FIXTURE ⇒ 105 W/FIXTURE
(MAJORITY OF LAMPS IN BLDG 25 WITH 3.9 W/SF - LOSS OF LUMENS SHOULD NOT AFFECT WORK)

RS&H®

SUBJECT: ENERGY LAMPS/BALLASTS — AEP NO 290-0379-002
SHEET 4 OF
DESIGNER: C. WARREN — DATE 3/26/92
CHECKER — DATE

8I. SAME AS 6; NON-PRODUCTION BLDGS

8J. SAME AS 7; NON-PRODUCTION BLDGS

LABOR AND MATERIAL COSTS / CONSTRUCTION COSTS
SHOWN ON FOLLOWING COST ESTIMATE SHEETS

REPLACEMENT COSTS

ASSUMPTIONS – 20,000 HRS LIFETIME FOR ALL LAMPS
NO BALLAST REPLACEMENTS
25 YR PROJECT LIFETIME
LABOR COSTS ARE SAME FOR STD VS ENERGY LAMPS

AVG LAMP REPLACEMENTS PER YR

(1) PRODUCTION AREAS F40 LAMPS & F96

$$\frac{20{,}000 \text{ HRS/LAMP}}{6{,}000 \text{ HRS/YR}} = 3.33 \frac{\text{YRS}}{\text{LAMP}}$$

$$\frac{308 \text{ LAMPS}}{3.33 \text{ YRS}} = 92.4 \text{ REPLACEMENTS/YR}$$

(2) NON-PRODUCTION F40/F96

$$\frac{20{,}000}{2750} = 7.27 \text{ YRS/LAMP}$$

$$\frac{7845}{7.27} = 1079 \text{ LAMPS/YR REPLACED}$$

RS&H®

SUBJECT Energy Lamps/Ballasts
DESIGNER C. Warren
CHECKER
AEP NO 290-0379-002
SHEET 5 OF
DATE 3/26/92
DATE

(3) PRODUCTION AREAS F96 LAMPS

$$\frac{6248 \text{ LAMPS}}{3.33 \text{ YRS}} = 1{,}876 \text{ REPL/YR}$$

(4) NON-PRODUCTION F96

$$\frac{1032}{7.27} = 142 \text{ REPL/YR}$$

REPLACEMENT LAMP COSTS -

	# REPLACEMENTS/YR	LAMP PRICE (EA)	TOTAL
PRODUCTION AREAS			
F40T12 (STD)	92	1.05	97
F40T12/WM	92	1.80	166
F32T8	92	2.10	193
F96T12 (STD)	1876	2.60	4878
F96T12/WM	1876	3.95	7410
NON-PRODUCTION AREAS			
F40T12 (STD)	1079	1.05	1133
F40 T12/WM	1079	1.80	1942
F32T8	1079	2.10	2266
F96T12 (STD)	142	2.60	369
F96T12/WM	142	3.95	560

SUMMARY OF SAVINGS FOR EACH ECO — PROJECT SUMMARY DATA FOLLOW ON PAGES 8-10 thru 8-14

FLUORESCENT LIGHTING S
WATERVLIET ARSENAL
DATES: 15 OCT 91 - 18
PROJECT # 290-0379-00

TABLE 8-1 FLUORESCENT LIGHTING INVENTORY

BLDG #	AREA	AVG W/SF	F40T12 # LTS	F40T12 # FXTRS	F96T12 # LTS	F96T12 # FXTRS	F96T12HO # LTS	F96T12HO # FXTRS	F90T12 # LTS	F90T12 # FXTRS	F90T17 # LTS	F90T17 # FXTRS	F72PG17 # LTS	F72PG17 # FXTRS	F96PG17 # LTS	F96PG17 # FXTRS	TOTAL LTS	TOTAL FXTRS
20	MANUF	1.9							1,728	864							1,728	864
25	MANUF	3.9			5,600	2,800											5,600	2,800
35	MANUF	N/A															0	0
110	MANUF	1.3	300	100	648	324			200	100							1,148	524
125	MANUF	1.5	8	4			184	92									192	96
135	MANUF	N/A															0	0
	TOTAL MANUF		308	104	6,248	3,124	184	92	1,928	964	0	0	0	0	0	0	8,668	4,284
10	OFFICES	0.9	1,042	377	4	2											1,046	379
15	MTR POOL	0.5	182	91	4	2											186	93
15	OFFICES	0.5	62	31													62	31
20	OFFICES	1.8	372	124													372	124
21	CAFETERIA	0.4	124	62													124	62
22	FIRE STA	N/A															0	0
23	MANUF/SPLY	0.9	212	82	90	45											302	127
24	OFFICES	1.2	114	57													114	57
40	OFFICES/LABS	1.3	860	430	188	94											1,048	524
44	OFFICES	1.4	1,512	454	166	83											1,678	537
115	OFFICES	1.2	1,451	598	20	10											1,471	608
120	STORAGE	0.6	104	52	158	79											262	131
120	SHOPS	1.1									252	126					252	126
120	OFFICES	1.2	352	176	10	5											362	181
120	LABS	1.8	950	475									60	30			1,010	505
123	CLEANING	1.3					42	21							24	12	66	33
124	OFFICES/LABS	1.2	360	180													360	180
130	WAREHOUSE	0.7	72	36	162	81					18	9					252	126
145	WAREHOUSE	0.2	76	38	230	115					12	6					318	159
	TOTAL OTHER		7,845	3,263	1,032	516	42	21	0	0	282	141	60	30	24	12	9,285	3,983
	TOTAL WVA	1.4	8,153	3,367	7,280	3,640	226	113	1,928	964	282	141	60	30	24	12	17,953	8,267

B-6

FLUORESCENT LIGHTING SURVEY - SUMMARY
WATERVLIET ARSENAL
DATES: 15 OCT 91 - 18 OCT 91
PROJECT # 290-0379-002

TABLE 8-2 FLUORESCENT LIGHTING CURRENT ENERGY USE

BLDG #	AREA	AVG W/SF	F40T12 WATTS	F40T12 KWH/YR	F96T12 WATTS	F96T12 KWH/YR	F96T12HO WATTS	F96T12HO KWH/YR	F90T12 WATTS	F90T12 KWH/YR	F90T17 WATTS	F90T17 KWH/YR	F72PG17 WATTS	F72PG17 KWH/YR	F96PG17 WATTS	F96PG17 KWH/YR	TOTAL WATTS	TOTAL KWH/YR
20	MANUF	1.9							172,800	1,036,800							172,800	1,036,800
25	MANUF	3.9			490,000	2,940,000											490,000	2,940,000
35	MANUF	N/A															0	0
110	MANUF	1.3	14,400	86,400	56,700	340,200			20,000	120,000							91,100	546,600
125	MANUF	1.5	384	2,304			23,460	140,760									23,844	143,064
135	MANUF	N/A															0	0
	TOTAL MANUF		14,784	88,704	546,700	3,280,200	23,460	140,760	192,800	1,156,800	0	0	0	0	0	0	777,744	4,666,464
10	OFFICES	0.9	50,016	137,544	350	963											50,366	138,507
15	MTR POOL	0.5	8,736	24,024	350	963											9,086	24,987
15	OFFICES	0.5	2,976	8,184													2,976	8,184
20	OFFICES	1.8	17,856	49,104													17,856	49,104
21	CAFETERIA	0.4	5,952	16,368													5,952	16,368
22	FIRE STA	N/A															0	0
23	MANUF/SPLY	0.9	10,176	38,352	7,875	21,656											18,051	60,008
24	OFFICES	1.2	5,472	15,048													5,472	15,048
40	OFFICES/LABS	1.3	41,280	113,520	16,450	45,238											57,730	158,758
44	OFFICES	1.4	72,576	199,584	14,525	39,944											87,101	239,528
115	OFFICES	1.2	69,648	191,532	1,750	4,813											71,398	196,345
120	STORAGE	0.6	4,992	13,728	13,825	38,019											18,817	51,747
120	SHOPS	1.1									27,090	74,498					27,090	74,498
120	OFFICES	1.2	16,896	46,464	875	2,406											17,771	48,870
120	LABS	1.8	45,600	125,400									11,385	31,309			56,985	156,709
123	CLEANING	1.3					5,355	32,130							5,520	33,120	10,875	65,250
124	OFFICES/LABS	1.2	17,280	47,520													17,280	47,520
130	WAREHOUSE	0.7	3,456	9,504	14,175	38,981					1,935	5,321					19,566	53,806
145	WAREHOUSE	0.2	3,648	10,032	20,125	55,344					1,290	3,548					25,063	68,924
	TOTAL OTHER		376,560	1,045,908	90,300	248,327	5,355	32,130	0	0	30,315	83,367	11,385	31,309	5,520	33,120	519,435	1,474,161
	TOTAL WVA	1.5	391,344	1,134,612	637,000	3,528,527	28,815	172,890	192,800	1,156,800	30,315	83,367	11,385	31,309	5,520	33,120	1,297,179	6,140,625

8-7

TABLE 8-3

FLUORESCENT LAMP SPECIFICATIONS
WVA - #290-0379-002
10-Feb-92

LAMP(1)	BULB DIAM *		WATTS	BASE	LIFE (HRS) 12-HR START	LUMENS	CURRENT (MA)	PRICE ($)
F40CW(GE)	1.5	STD	40	BIPIN	20000	3050	425	
F40CW(P)	1.5	STD	40	BIPIN	20000	3150	425	
F40CW/RS/WM(GE)	1.5	ENERGY	34	BIPIN	20000	2650	425	$1.80
F40CW/RS/EW-II(P)	1.5	ENERGY	34	BIPIN	20000	2775	425	
F40/CW/EW-PH(P)	1.5	ENERGY	34	BIPIN	15000	2850	425	
F40CW/RS/WMP(GE)	1.5	ENERGY	32	BIPIN	15000	2525	425	$2.10
F40T8(GE)	1.0	STD	40	BIPIN	20000	3600	265	
F40T8(P)	1.0	STD	40	BIPIN	20000	3650	265	
F32T8(P)	1.0	ENERGY	32	BIPIN	20000	2900	265	$2.10
F040T8(S)	1.0	STD	40	BIPIN	20000	3650	265	
F032T8(S)	1.0	ENERGY	32	BIPIN	20000	2900	265	
F72PG17(GE)	2.125	STD	165	RDC	15000	11000	1500	
F96T12/CW(GE)	1.5	STD	75	SINGLE	18000	6150	425	
F96T12/CW(P)	1.5	STD	75	SINGLE	12000	6300	425	
F96T12/CW/WM(GE)	1.5	ENERGY	60	SINGLE	18000	5500	425	$3.95
F96T12/CW/EW(P)	1.5	ENERGY	60	SINGLE	12000	5600	425	
F96T12/CW/HO(GE)	1.5	STD	105	RDC	18000	8900	800	
F96T12/CW/HO(P)	1.5	STD	105	RDC	12000	9200	800	
F96T12/CW/HO/WM(GE)	1.5	ENERGY	95	RDC	18000	8000	800	$5.30
F96T12/CW/HO/EW(P)	1.5	ENERGY	95	RDC	12000	8300	800	
F96PG17/CW(GE)	2.125	STD	215	RDC	15000	15300	1500	
F96PG17/CW/WM(GE)	2.125	ENERGY	185	RDC	15000	13500	1500	$11.45
F90T17/CW(GE)	2.125	STD	90	MOG BIP	15000	6000	425	
F90T17/CW/WM(GE)	2.125	ENERGY	82	MOG BIP	15000	5750	425	$9.00
F90T12/CW/60/EW(P) (REPLACES F90T17/CW)	1.5	ENERGY	84	MOG BIP	9000	6250	425	$9.00

(1) GENERAL ELECTRIC (GE)
PHILIPS (P)
SYLVANIA (S)

SOURCES: SPECIFICATIONS FROM MANUF. CATALOGS
PRICE QUOTES FROM VENDORS

TABLE 8-4

FLUORESCENT BALLAST SPECIFICATIONS
WVA - #290-0379-002
12-Feb-92

LAMPS	WATTS	BALLASTS	BALLAST INPUT (W)	PRICE ($)
F40T12/RS	40	ADV MARK IV	80	$20.00
STD		EBT ELECTRONIC	71	
		GE OPTIMISER	71	
		GE PERFORMANCE SS	70	
		STANDARD	96	
F40T12/RS	34	ADV MARK IV	66	$20.00
ENERGY		EBT ELECTRONIC	59	$25.20
		GE OPTIMISER	59	
F40T12/RS	32	GE MAXI-MISER II	72	
ENERGY				
F40T8/IS	40	EBT ELECTRONIC	70	
STD				
F32T8/IS	32	EBT ELECTRONIC	58	$26.90
ENERGY		T8 MAGNETIC	66	
F96T12/IS	75	GE MAXI-MISER II	158	
STD		EBT ELECTRONIC	130	
		STANDARD	175	
F96T12/IS	60	GE MAXI-MISER II	136	
ENERGY		EBT ELECTRONIC	105	$35.00
F96T12/HO	105	GE WATT-MISER	237	
STD		GE MAXI-MISER II	254	
		STANDARD	255	
		EBT ELECTRONIC	190	
F96T12/HO	95	GE MAXI-MISER II	212	
ENERGY		EBT ELECTRONIC	160	$44.00
F96PG17				
STD	215	STANDARD	460	
ENERGY	185	STANDARD	400	
F90T17				
STD	90	STANDARD	215	
ENERGY	82	STANDARD	200	
F90T12	84	STANDARD	200	

SOURCES: SPECIFICATIONS FROM MANUF. CATALOGS

PRICES FROM VENDORS

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8A
Replace 40-Watt Fluorescents with 34-Watt Lamps
Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM Std. Bal.	Savings
Number Lamps	308.0	308.0	0.0
Number Fixtures	104.0	104.0	0.0
Number Ballasts	152.0	152.0	0.0
Load, kW	14.8	12.4	2.5
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	303.7	253.1	50.6
Lamp Repl Cost, $/yr	97.0	166.0	-69.0
Rebate Amt., $	0.0	-123.2	123.2

8B
Replace 40-Watt Fluorescents with 34-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electromagnetic Ballasts
Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM EM Bal.	Savings
Number Lamps	308.0	308.0	0.0
Number Fixtures	104.0	104.0	0.0
Number Ballasts	152.0	152.0	0.0
Load, kW	14.8	9.8	5.0
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	302.7	200.4	102.4
Lamp Repl Cost, $/yr	97.0	166.0	-69.0
Rebate Amt., $	0.0	-3163.2	3163.2

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8C
Replace 40-Watt Lamps and Ballasts with T8 System
Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T8 Elect. Bal.	Savings
Number Lamps	308.0	308.0	0.0
Number Fixtures	104.0	104.0	0.0
Number Ballasts	152.0	102.0	50.0
Load, kW	14.8	9.1	5.7
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	302.7	185.6	117.1
Lamp Repl Cost, $/yr	97.0	193.0	-96.0
Rebate Amt., $	0.0	-2203.2	2203.2

8D
Replace 40-Watt Fluorescents with 34-Watt Lamps
Non-Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM Std. Bal.	Savings
Number Lamps	7845.0	7845.0	0.0
Number Fixtures	3263.0	3263.0	0.0
Number Ballasts	3923.0	3923.0	0.0
Load, kW	376.6	313.8	62.7
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	3534.3	2945.6	588.7
Lamp Repl Cost, $/yr	1133.0	1942.0	-809.0
Rebate Amt., $	0.0	-3138.0	3138.0

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8E
Replace 40-Watt Fluorescents with 34-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electromagnetic Ballasts
Non-Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T12/WM EM Bal.	Savings
Number Lamps	7845.0	7845.0	0.0
Number Fixtures	3263.0	3263.0	0.0
Number Ballasts	3923.0	3923.0	0.0
Load, kW	376.6	258.9	117.6
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	3534.3	2430.1	1104.2
Lamp Repl Cost, $/yr	1133.0	1942.0	-809.0
Rebate Amt., $	0.0	-81598.0	81598.0

8F
Replace 40-Watt Lamps and Ballasts with T8 System
Non-Production Areas

	Existing F40T12 Std. Bal.	Proposed F40T8 Elect. Bal.	Savings
Number Lamps	7845.0	7845.0	0.0
Number Fixtures	3263.0	3263.0	0.0
Number Ballasts	3923.0	3923.0	0.0
Load, kW	376.6	227.5	149.0
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	3534.3	2135.6	1398.7
Lamp Repl Cost, $/yr	1133.0	2266.0	-1133.0
Rebate Amt., $	0.0	-81598.0	81598.0

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8G
Replace 75-Watt Fluorescents with 60-Watt Lamps
Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Std. Bal.	Savings
Number Lamps	6248.0	6248.0	0.0
Number Fixtures	3124.0	3124.0	0.0
Number Ballasts	3124.0	3124.0	0.0
Load, kW	546.7	509.2	37.5
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	11195.3	10427.4	767.9
Lamp Repl Cost, $/yr	4878.0	7410.0	-2532.0
Rebate Amt., $	0.0	-2499.2	2499.2

8H
Replace 75-Watt Fluorescents with 60-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electronic Ballasts
Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Elect. Bal.	Savings
Number Lamps	6248.0	6248.0	0.0
Number Fixtures	3124.0	3124.0	0.0
Number Ballasts	3124.0	3124.0	0.0
Load, kW	546.7	328.0	218.7
Use, Hrs/yr	6000.0	6000.0	0.0
Use MBtu/yr	11195.3	6717.2	4478.1
Lamp Repl Cost, $/yr	4878.0	7410.0	-2532.0
Rebate Amt., $	0.0	-64979.2	64979.2

PROJECT SUMMARY DATA
WATERVLIET ARSENAL

PROJECT: ECO #8
ENERGY EFFICIENT FLUORESCENT LAMPS AND BALLASTS

8I
Replace 75-Watt Fluorescents with 60-Watt Lamps
Non-Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Std. Bal.	Savings
Number Lamps	1032.0	1032.0	0.0
Number Fixtures	516.0	516.0	0.0
Number Ballasts	516.0	516.0	0.0
Load, kW	90.3	84.1	6.2
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	847.5	789.3	58.2
Lamp Repl Cost, $/yr	369.0	560.0	-191.0
Rebate Amt., $	0.0	-412.8	412.8

8J
Replace 75-Watt Fluorescents with 60-Watt Lamps
Replace Standard Ballasts with Energy - Efficient Electronic Ballasts
Non-Production Areas

	Existing F96T12 Std. Bal.	Proposed F96T12/WM Elect. Bal.	Savings
Number Lamps	1032.0	1032.0	0.0
Number Fixtures	516.0	516.0	0.0
Number Ballasts	516.0	516.0	0.0
Load, kW	90.3	54.2	36.1
Use, Hrs/yr	2750.0	2750.0	0.0
Use MBtu/yr	847.5	508.5	339.0
Lamp Repl Cost, $/yr	369.0	560.0	-191.0
Rebate Amt., $	0.0	-10732.8	10732.8

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Production Areas

ECO #: 8A

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$554
Labor	$693
Subtotal bare costs	$1,247
FICA Insurance (20% of Labor)	$139
Sales Tax (not applicable for GOGO)	$0
Subtotal	$1,386
Overhead (15%)	$208
Subtotal	$1,594
Profit (10%)	$159
Subtotal	$1,753
Bond (1%)	$18
Subtotal	$1,771
Contingency (10%)	$177
Subtotal (Construction Cost Input For LCCID *)	$1,948
SIOH (6% of Construction Cost)	$117
Subtotal	$2,065
Design (6% of Construction Cost)	$117
Total Project Cost	$2,182

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Replace Standard Ballasts With Energy EM Ballasts
Production Areas

ECO #: 8B

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$3,594
Labor	$3,885
Subtotal bare costs	$7,479
FICA Insurance (20% of Labor)	$777
Sales Tax (not applicable for GOGO)	$0
Subtotal	$8,256
Overhead (15%)	$1,238
Subtotal	$9,494
Profit (10%)	$949
Subtotal	$10,443
Bond (1%)	$104
Subtotal	$10,547
Contingency (10%)	$1,055
Subtotal (Construction Cost Input For LCCID *)	$11,602
SIOH (6% of Construction Cost)	$696
Subtotal	$12,298
Design (6% of Construction Cost)	$696
Total Project Cost	$12,994

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 32-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Production Areas

ECO #: 8C

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$3,639
Labor	$2,835
Subtotal bare costs	$6,474
FICA Insurance (20% of Labor)	$567
Sales Tax (not applicable for GOGO)	$0
Subtotal	$7,041
Overhead (15%)	$1,056
Subtotal	$8,097
Profit (10%)	$810
Subtotal	$8,907
Bond (1%)	$89
Subtotal	$8,996
Contingency (10%)	$900
Subtotal (Construction Cost Input For LCCID *)	$9,896
SIOH (6% of Construction Cost)	$594
Subtotal	$10,490
Design (6% of Construction Cost)	$594
Total Project Cost	$11,084

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Non-Production Areas

ECO #: 8D

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$14,121
Labor	$17,651
Subtotal bare costs	$31,772
FICA Insurance (20% of Labor)	$3,530
Sales Tax (not applicable for GOGO)	$0
Subtotal	$35,302
Overhead (15%)	$5,295
Subtotal	$40,597
Profit (10%)	$4,060
Subtotal	$44,657
Bond (1%)	$447
Subtotal	$45,104
Contingency (10%)	$4,510
Subtotal (Construction Cost Input For LCCID *)	$49,614
SIOH (6% of Construction Cost)	$2,977
Subtotal	$52,591
Design (6% of Construction Cost)	$2,977
Total Project Cost	$55,568

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 40-Watt Fluorescents With 34-Watt Lamps
Replace Standard Ballasts With Energy EM Ballasts
Non-Production Areas

ECO #: 8E

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$92,581
Labor	$100,034.
Subtotal bare costs	$192,615
FICA Insurance (20% of Labor)	$20,007
Sales Tax (not applicable for GOGO)	$0
Subtotal	$212,622
Overhead (15%)	$31,893
Subtotal	$244,515
Profit (10%)	$24,452
Subtotal	$268,967
Bond (1%)	$2,690
Subtotal	$271,657
Contingency (10%)	$27,166
Subtotal (Construction Cost Input For LCCID *)	$298,823
SIOH (6% of Construction Cost)	$17,929
Subtotal	$316,752
Design (6% of Construction Cost)	$17,929
Total Project Cost	$334,681

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/19/92

ECO Construction Cost Estimate Calculations

ECO Name: Replace 40-Watt Fluorescents With 32-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Non-Production Areas

ECO #: 8F

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$122,395
Labor	$100,034
Subtotal bare costs	$222,429
FICA Insurance (20% of Labor)	$20,007
Sales Tax (not applicable for GOGO)	$0
Subtotal	$242,436
Overhead (15%)	$36,365
Subtotal	$278,801
Profit (10%)	$27,880
Subtotal	$306,681
Bond (1%)	$3,067
Subtotal	$309,748
Contingency (10%)	$30,975
Subtotal (Construction Cost Input For LCCID *)	$340,723
SIOH (6% of Construction Cost)	$20,443
Subtotal	$361,166
Design (6% of Construction Cost)	$20,443
Total Project Cost	$381,609

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Production Areas

ECO #: 8G

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$24,680
Labor	$15,620
Subtotal bare costs	$40,300
FICA Insurance (20% of Labor)	$3,124
Sales Tax (not applicable for GOGO)	$0
Subtotal	$43,424
Overhead (15%)	$6,514
Subtotal	$49,938
Profit (10%)	$4,994
Subtotal	$54,932
Bond (1%)	$549
Subtotal	$55,481
Contingency (10%)	$5,548
Subtotal (Construction Cost Input For LCCID *)	$61,029
SIOH (6% of Construction Cost)	$3,662
Subtotal	$64,691
Design (6% of Construction Cost)	$3,662
Total Project Cost	$68,353

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Production Areas

ECO #: 8H

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$134,020
Labor	$93,720
Subtotal bare costs	$227,740
FICA Insurance (20% of Labor)	$18,744
Sales Tax (not applicable for GOGO)	$0
Subtotal	$246,484
Overhead (15%)	$36,973
Subtotal	$283,457
Profit (10%)	$28,346
Subtotal	$311,803
Bond (1%)	$3,118
Subtotal	$314,921
Contingency (10%)	$31,492
Subtotal (Construction Cost Input For LCCID *)	$346,413
SIOH (6% of Construction Cost)	$20,785
Subtotal	$367,198
Design (6% of Construction Cost)	$20,785
Total Project Cost	$387,983

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Non-Production Areas

ECO #: 8I

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$4,076
Labor	$2,580
Subtotal bare costs	$6,656
FICA Insurance (20% of Labor)	$516
Sales Tax (not applicable for GOGO)	$0
Subtotal	$7,172
Overhead (15%)	$1,076
Subtotal	$8,248
Profit (10%)	$825
Subtotal	$9,073
Bond (1%)	$91
Subtotal	$9,164
Contingency (10%)	$916
Subtotal (Construction Cost Input For LCCID *)	$10,080
SIOH (6% of Construction Cost)	$605
Subtotal	$10,685
Design (6% of Construction Cost)	$605
Total Project Cost	$11,290

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

03/23/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace 75-Watt Fluorescents With 60-Watt Lamps
Replace Standard Ballasts With Electronic Ballasts
Non-Production Areas

ECO #: 8J

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$22,136
Labor	$15,480
Subtotal bare costs	$37,616
FICA Insurance (20% of Labor)	$3,096
Sales Tax (not applicable for GOGO)	$0
Subtotal	$40,712
Overhead (15%)	$6,107
Subtotal	$46,819
Profit (10%)	$4,682
Subtotal	$51,501
Bond (1%)	$515
Subtotal	$52,016
Contingency (10%)	$5,202
Subtotal (Construction Cost Input For LCCID *)	$57,218
SIOH (6% of Construction Cost)	$3,433
Subtotal	$60,651
Design (6% of Construction Cost)	$3,433
Total Project Cost	$64,084

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED 2/13/92

SHEET 1 OF 2

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WVA

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- ☐ CODE A (No design completed)
- ☒ CODE B (Preliminary design)
- ☐ CODE C (Final design)
- ☐ OTHER (Specify)

DRAWING NO.

ESTIMATOR: C. WARREN

CHECKED BY: P. Hutchins

ECO8 SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
F40T12 LAMP REPLACEMENTS							
& BALLAST REPLACEMENTS							
(1) PRODUCTION AREAS							
8A 34 W LAMPS	308	EA	2.25	693	1.80	554	1,247
NO BALLAST REPLACEMENTS							
8B 34 W LAMPS	308	EA	2.25	693	1.80	554	1,247
ENERGY EM BALLASTS	152	EA	21.00	3,192	20.00	3,040	6,232
				3,885		3,594	7,479
8C 32 W LAMPS (T8)	308	EA	2.25	693	2.10	647	1,340
ELECTRONIC BALLASTS	102	EA	21.00	2,142	29.33	2,992	5,134
				2,835		3639	6,474
NON-PRODUCTION AREAS							
8D 34 W LAMPS	7845	EA	2.25	17,651	1.80	14,121	31,772
NO BALLAST REPLACEMENTS							
8E 34 W LAMPS	7845	EA	2.25	17,651	1.80	14,121	31,772
ENERGY EM BALLASTS	3923	EA	21.00	82,383	20.00	78,460	160,843
				100,034		92,581	192,615
8F 32 W LAMPS (T8)	7845	EA	2.25	17,651	2.10	16,474	34,125
ELECTRONIC BALLASTS	3923	EA	21.00	82,383	27.00	105,921	188,304
				100,034		122,395	222,429

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—510148

CONSTRUCTION COST ESTIMATE

DATE PREPARED: 2/13/92

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WVA

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- ☐ CODE A (No design completed)
- ☐ CODE B (Preliminary design)
- ☐ CODE C (Final design)
- ☐ OTHER (Specify)

DRAWING NO.:

ESTIMATOR: C. WARREN

CHECKED BY:

ECO 8 SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
F96T12 LAMP &							
BALLAST REPLACEMENTS							
PRODUCTION AREAS							
8G 60 W LAMPS	6248	EA	2.50	15,620	3.95	24,680	40,300
NO BALLAST REPLACE							
8H 60 W LAMPS	6248	EA	2.50	15,620	3.95	24,680	40,300
ELECTRONIC BALLASTS	3124	EA	25.00	78,100	35.00	109,340	187,440
				93,720		134,020	227,740
NON-PRODUCTION AREAS							
8I 60 W LAMPS	1032	EA	2.50	2,580	3.95	4,076	6,656
NO BALLAST REPLACE							
8J 60 W LAMPS	1032	EA	2.50	2,580	3.95	4,076	6,656
ELECTRONIC BALLASTS	516	EA	25.00	12,900	35.00	18,060	30,960
				15,480		22,136	37,616

ENG FORM 1 AUG 59 150 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

RS&H

Architecture, Engineering and Planning

Reynolds, Smith and Hills, Inc.
4651 Salisbury Road
Jacksonville, Florida 32256

FACSIMILE TRANSMITTAL LETTER

DATE 2/10/92

(813) 282-1157

~~TO:~~ From → ELECTRONIC BALLAST TECHNOLOGY - Swanson & Co. Tampa

~~FROM:~~ To → DR CARLOS WARREN, PE (904) 279-2275

FAX NO. (213) 534-8214

PTAC NUMBER 599361

PROJECT NUMBER: —

TASK NO: —

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COMMENTS: I NEED PRICE QUOTES FOR BULK PURCHASES OF FOLLOWING BALLASTS

SSB1 - 120 - 3/40 LH	25.20 ea.
SSB1 - 277 - 2/96 HO LH	44.80 ea.
SSB2 - 120 - 2/96 IS LH	35.00 ea.
SSB1 - 120 - 2/96 HO LH	44.80 ea.
SSB2 - 120 - 2/32 IS LH	26.90 ea.

PLEASE QUOTE ASAP Thanks Carlos

SSB2 - 120 - 3/32 IS LH 29.33

~~To~~ From: Jim Reynolds

~~From~~ To: Carlos Warren
RS&H

Quotes on the following (bulk quantities)

Lamps -

GE F40CW/RS/WM 1.80 ea
F40 ~~CW~~ LW/RS/WM Plus 2.10 ea
F96T12/CW/WM 3.95 ea
F96T12/CW/HO/WM 5.30 ea
F96PG17/CW/WM 11.45 ea
F90T17/CW/WM 9.00 ea

or equivalent
~~Philips, Sylvania~~

Philips F90T12 CW/60/EW $9.00
FO 32/35 $2.10

Ballasts (2 lamp fixtures)
Advance Powerkut Mark IV RK-2S40-TP 20.00 ea
VK-2S40-TP 22.00 ea
GE Optimiser M28-120
Maxi-Miser II 8G1028W, 8G1148W, 8G1144W,
8G1008W, 8G1004W

EBT SSB1-120-2/40 LH SSB2-120-2/96 IS LH SSB1-120-2/96 HO LH
SSB1-277-2/96 HO LH, SSB2-120-3/32 IS LH

WATERVLIET ARSENAL
SELF-SERVICE SUPPLY CENTER
- MASTER LIST OF SUPPLIES -
REPAIR & UTILITY

5

STOCK NUMBER	NOMENCLATURE	MAT-CAT	UNIT ISSUE	UNIT PRICE
6240000000022	LAMP, INDICATOR, #CM7-7632	T	EA	$ 1.52
6240000726127	LAMP, INDICATOR, G.E. #253X	T	EA	$ 3.34
6240005191152	LAMP, INSIDE FROST, 50 WATT, 250 VOLT, A19 BULB, MEDIUM BASE, G.E. #50A	T	EA	$ 1.16
6240010978687	LAMP, LOW PRESSURE SODIUM, CLEAR, T-12 BULB, BASE BT22D, 90 WATT	T	EA	$ 31.38
6240010978686	LAMP, LOW PRESSURE SODIUM, CLEAR, T-17 BULB, BASE BY22D, 55 WATT	T	EA	$ 21.95
6240008856852	LAMP, MERCURY, 400 WATTS, E-37 BULB, MOGUL BASE, DELUXE WHITE G.E. #H-400DX33-1	T	EA	$ 10.34
624000X000001	LAMP, QUARTZ, 85 WATTS, 13.8 VOLTS	T	EA	$ 12.26
6240009516643	LAMP, REFRIGERATOR, G.E. #15 S11/A02	T	EA	$ .96
6240001863264	LAMP, SHOWCASE, CLEAR, G.E. #40-T10	T	EA	$ 1.13
6240005042507	LAMP, SHOWCASE, G.E. #25T6-1/2IF	T	EA	$ .40
6240009855239	LAMP, 40 WATT BULB, NO. T-10, BASE; 4-PIN, COOL WHITE, RAPID START, 16"DIA., G.E., #FC16T10/CW/RS	T	EA	$ 4.00
6240001520000	LAMP, 40 WATT, 115/125 VOLTS, INSIDE FROST STANDARD BASE. COLOR:RED	T	EA	$ .83
> 6240005190158	LAMP, FLOURESCENT F40 CW STANDARD, NON-ESS	T	EA	$ 1.05
> 6240009892421	LAMP, FLOURESCENT, 75 WATTS, T-12 BULB SINGLE PIN BASE, 525 MA, LENGTH 96" F96T12/CW	T	EA	$ 2.60
624000X800002	LAMP, FLOURESENT, TUBE, F6T5	T	EA	$ 2.30
> 6240009738237	LAMP, FLUORESCENT, 110 VOLTS, BULB #T12, BASE RECESS DC, MAX OVERALL LENGTH INCHES F96T12/CW/HO HIGH OUTPUT	T	EA	$ 1.94
> 6240002477348	LAMP, FLUORESCENT, 90 WATT, T-12 BULB, COLOR: COOL WHITE, BASE BIPIN 8.20 5 ft LONG SPECIAL, PHILLIPS MFG F90T12	T	EA	$ 6.99

STOCK NUMBER	NOMENCLATURE	MAT-CAT	UNIT ISSUE	UNIT PRICE
6240007522081	LAMP,FLUORESCENT,POWER GROOVE F96PG17/CW	T	EA	$ 10.15
6240005190445	LAMP,FLUORESCENT,WATTS 32,BULB NO.T-10 BASE,4-PIN,COOL WHITE,RAPID START,12"DIA	T	EA	$ 4.00
6240008200470	LAMP,FLUORESCENT,WATT 14,BULB T-12,MED. BI-PIN BASE,WARM WHITE	T	EA	$ 3.86
6240000671021	LAMP,FLUORSCENT TUBE, 6FOOT,POWER GROOVE "POWER GROOVE" 1500M.A.165 WATTS RAIPID START F72T12PG	T	EA	$ 4.92
6240006354480	LAMP,INCANDESCENT 60 WATT,120 VOLTS MED. SCREW BASE,INSIDE FROSTED,A-19 BULB	T	EA	$ .38
6240002239097	LAMP,INCANDESCENT CLEAR,1/4 WATT,105-125 VOLT CANDLE BASE	T	EA	$ 4.67
6240001433049	LAMP,INDICATOR,6 WATTS,110 VOLTS, CLEAR G.E. #656	T	EA	$ .16
6240001558001	LAMP,INDICATOR,CLEAR,CANDLEABRA BASE 10 WATTS 230 VOLTS, G.E. 1056-10	T	EA	$ 2.26
6240007123090	LAMP,REFLECTOR,INFRE-RED,RED BOWL,250 WATTS,125 VOLTS,OR 120 VOLTS	T	EA	$ 3.08
6240007818372	LAMP,STREET LIGHTING,6000 LUMENEARS BULB 6.6,MOGUL BASE,CLEAR	T	EA	$ 7.50
6240005003643	LAMP,TRAFFIC SIGNAL,CLEAR,60 WATTS,120 VOLTS,BULB A21	T	EA	$ .81
624000X810003	LAMP,U SHAPED FLU	T	EA	$ 5.88
6240006171713	LAMP,WHITE 7-1/2 WATTS,120 VOLTS	T	EA	$ .85
6250006906155	LAMPHOLDER THREE GANG COVER ONLY	T	EA	$ 1.50
6250002996327	LAMPHOLDER, BRASS, PULLCHAIN, MED. BASE	T	EA	$ 1.50
6250006906165	LAMPHOLDER, FLOODLIGHT, WITHOUT COVER-PLATE	T	EA	$ 2.25

8-30

1 MAR TIME 08:42 WATERVLIET ARSENAL SELF-SERVICE SUPPLY CENTER - MASTER LIST OF SUPPLIES - REPAIR & UTILITY H05DXXL014L MAT-CAT UNIT ISSUE UNIT PRICE

8-31

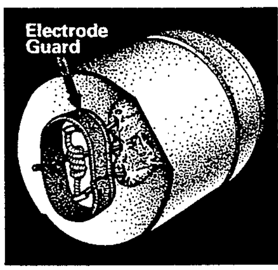
STOCK NUMBER	NOMENCLATURE	MAT-CAT	UNIT ISSUE	UNIT PRICE
473000X879009	ADAPTER,MALE COPPER SWEAT TO PIPE THREAD 1-1/2"	T	EA	$ 1.47
8040002254548	ADHESIVE SEALANT, WHITE SILICONE RUBBER CAULKING, R.T.V.	T	EA	$ 2.29
951000X830002	ALL THREADED ROD, 1/4" X 6' LENGHT	T	EA	$ .63
5975000001985	ANCHOR,SCREW,PLASTIC,1"LONG FOR #12X1" SHEET METAL SCREW	T	EA	$ .03
5340005402270	ANCHOR,WOOD SCREW MULTI SIZE FOR USE WITH #10 TO #14 WOOD SCREW, 1-1/2" LONG	T	EA	$ .06
5975006908890	ANCHOR,WOOD SCREW,MULTI SIZE,FOR USE WITH #10 TO #14 WOOD SCREW,1" LONG, DIAMOND #5316	T	EA	$ .03
8105002811158	BAG,BROWN PAPER 2 LB.	T	PK	$ 3.90
8105005592561	BAG,BROWN PAPER GROCERS TYPE #1	T	BE	$ .15
8105002811163	BAG,GROCERS,35 LB WT,POPULAR WEIGHT,5 LB 500 EACH PACKAGE, 3000 EACH PER BALE	T	PK	$ 3.90
> 6250006906030	BALLAST,118 VOLT,1.55 AMP,G.E.CAT.7G1011 FOR USE WITH LAMP 96T12 OR EQUAL	T	EA	$ 11.76
6250008259422	BALLAST,ADVANCE, 1-14, 15, 20 OR 22 WATT FLOURESCENT, RLQ-120	T	EA	$ 5.86
> 625000X889034	BALLAST,ELECTRONIC,LIGHTING FOR TWO F96/277 VOLT FLOURESCENT LAMPS. SINGLE PIN. MODEL #US-800SS	T	EA	$ 19.10
> 6250006906125	BALLAST,FOR USE WITH TWO,40 WATT,RAPID START LAMPS IN SERIES (REF.ADVANCE CAT. RQM 2S40) NO SUBSITUTE	T	EA	$ 7.75
482000X889012	BALLCOCK,FLUIDMASTERR,400A SERIES	T	EA	$ 7.40
5920006915304	BASE,FUSE CUTOUT,SINGLE POLE,FOR TYPE BBS FUSES,600 VOLTS PORCELAIN	T	EA	$ 1.54

1 MAR TIME 08:42 WATERVLIET ARSENAL SELF-SERVICE SUPPLY CENTER - MASTER LIST OF SUPPLIES - REPAIR & UTILITY H05DXXL014L GROUP 2 PAGE

TL 80 Series Fluorescent Lamps
Electrical, Technical and Ordering Data (Subject to change without notice)

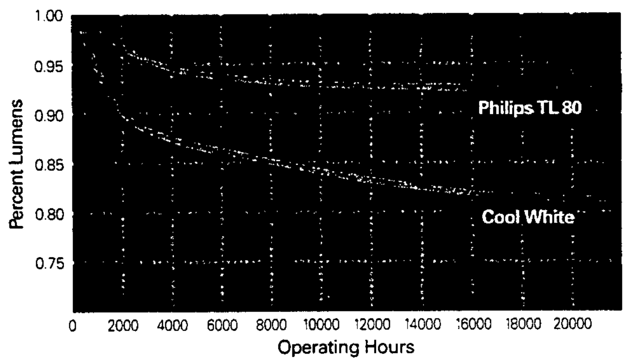
Product Number 046677-	Description	Nominal Watts	Bulb	Base	Std Pkg Qty	Lamp Current (Amps)	Color Temp (Kelvin)	Color Rendering (CRI)	Nominal Length (Feet)	Rated Average Life (Hrs)[1]	Approx. Initial Lumens	Design Lumens[2]
31980-6	F17T8/TL830	17	T-8	Md. Bipin	25	0.265	3000	85	2	20,000	1400	1300
32304-8	F17T8/TL835	17	T-8	Md. Bipin	25	0.265	3500	85	2	20,000	1400	1300
31983-0	F17T8/TL841	17	T-8	Md. Bipin	25	0.265	4100	85	2	20,000	1400	1300
31984-8	F25T8/TL830	25	T-8	Md. Bipin	25	0.265	3000	85	3	20,000	2250	2100
25798-0	F25T8/TL835	25	T-8	Md. Bipin	25	0.265	3500	85	3	20,000	2250	2100
31989-7	F25T8/TL841	25	T-8	Md. Bipin	25	0.265	4100	85	3	20,000	2250	2100
31991-3	F32T8/TL830	32	T-8	Md. Bipin	25	0.265	3000	85	4	20,000	3050	2850
31993-9	F32T8/TL835	32	T-8	Md. Bipin	25	0.265	3500	85	4	20,000	3050	2850
31994-7	F32T8/TL841	32	T-8	Md. Bipin	25	0.265	4100	85	4	20,000	3050	2850
31996-2	F40T8/TL830	40	T-8	Md. Bipin	25	0.265	3000	85	5	20,000	3800	3550
25799-8	F40T8/TL835	40	T-8	Md. Bipin	25	0.265	3500	85	5	20,000	3800	3550
31998-8	F40T8/TL841	40	T-8	Md. Bipin	25	0.265	4100	85	5	20,000	3800	3550

(1) Average life under specified test conditions with lamps turned off and restarted no more than once every 3 operating hours.
(2) Approximate lumens at 40% of rated average life (8000 Hours).



For maximum lumen maintenance, TL 80 Series lamps feature an "electrode guard" around each electrode to effectively reduce lamp darkening and retain a clean appearance for thousands of hours.

Lumen Maintenance: TL 80 vs. Cool White



Philips Lighting specialists are ready to help.

Philips Lighting has a team of specialists dedicated to commercial/office and retail lighting applications. They can provide a free lighting analysis which demonstrates how Philips TL 80 Series lamps can reduce energy costs in your building and improve the quality of light at the same time.

Call your Philips Lighting representative for a free fluorescent lighting analysis today: **1-800-631-1259.**

TL 80 System – lamp specification

"Lamps shall be Philips TL 80 Series lamps having:
- Color rendering index of 85
- T-8 diameter bulb
- Medium bi-pin bases
- Color temperature of ________ K (3000, 3500 or 4100)
- Initial lumens of ________ (1400, 2250, 3050 or 3800)
- Nominal wattage of ________ (17, 25, 32, 40)
- Powered by electronic ballasts designed for 265ma T-8 lamps
- An electrode guard."

SYSTEM PERFORMANCE

Because the 32-watt, T8 lamp would not operate properly on existing forty-watt, 430 ma. ballasts, design of the Octron lamp system was accomplished without the constraints of existing fluorescent systems. The goal was to optimize total system performance to the F40T12 system in a luminaire while reducing wattage significantly. The result is the most efficient full light output energy-saving fluorescent lighting system.

In designing the Octron lamp system, a number of factors did have to be taken into consideration. One was the ballast factor (ratio of light output when operated on commercially-available ballasts as compared to a reference circuit.) The ballast factor of the Octron magnetic ballast was set at nominal .95; rated lumens and lamp wattage were then established.

Other factors considered were the thermal effects, i.e. 2900 rated lumens of the Octron lamp versus the 3050 lumen rating of F40CW lamps, versus the lumen output of the same lamps when operated in a stabilized condition in the luminaire. Then there were the optical effects to be considered, i.e. better lighting control, and the trapping of less light by the fixture walls and bulb itself.

The true metric for comparison of the fluorescent lamps is their actual performance in a lighting system. The data shown in Figure 7 are the result of the systems approach to lamp design taking into consideration all of the above mentioned factors. In these tests, each fluorescent system was operated in the same 4-lamp recessed lensed troffer, in a room ambient temperature of 77°F. The plenum was allowed to stabilize prior to collection of system wattage and relative lumen output data. The F40CW/standard magnetic ballast was used as the base system, and set at 100% Relative Light Output. As Figure 8 illustrates, data were collected concerning watts, Relative Light Output and RLO/watt for each lamp type and ballast tested.

Results show that Octron lamps operated on magnetic ballasts deliver system efficiency equal to T12 34-watt energy-saving lamps operated on electronic ballasts. Furthermore, the tests show that Octron lamps operated on T8 electronic ballasts provide the highest system efficiency — 166 RLO/watt.

(FIGURE 7)

FIXTURE COMPARISON DATA (77° TEST ROOM - 4-LAMP RECESSED TROFFER, PLASTIC LENS)

LAMP TYPE	BALLAST	BALLAST FACTOR[1]	WATTS	RELATIVE LIGHT OUTPUT (RLO)[2]	RLO/W
SYLVANIA F40CW	STD. MAGNETIC	.95	174	100	100
SYLVANIA 34W SUPERSAVER® D841	STD. MAGNETIC	.90	155	95	107
SYLVANIA 32W SUPERSAVER PLUS D841	STD. MAGNETIC	.90	144	93	113
SYLVANIA F40CW	ENERGY SAVING MAGNETIC	.95	162	101	108
SYLVANIA 34W SUPERSAVER D841	ENERGY SAVING MAGNETIC	.88	139	93	116
SYLVANIA 32W SUPERSAVER PLUS D841	ENERGY SAVING MAGNETIC	.88	131	91	122
SYLVANIA 34W SUPERSAVER D841	ELECTRONIC	.75	119	93	136
SYLVANIA FO32 OCTRON®	T8 MAGNETIC	.95	132	104	137
SYLVANIA FO32 OCTRON®[3]	T8 ELECTRONIC	.92	106	101	166

1 DATA IN TEST NORMALIZED TO BALLAST FACTORS SHOWN IN THIS COLUMN FOR MAGNETIC BALLASTS. FACTORS SHOWN FOR ELECTRONIC BALLASTS ARE MEASURED VALUES OF SAMPLE.

2 RELATIVE LIGHT OUTPUT BASED ON INITIAL (100 HOUR) RATED LAMP LUMEN OUTPUT AS OF 8/22/83.

3 LIFE RATED AT 15,000 HOURS. ALL OTHER SYSTEMS SHOWN ARE RATED AT 20,000 HOURS.

8-33

OCTRON CURVALUME LAMPS

An Octron Curvalume family has been introduced to provide greater lighting design, flexibility and higher efficiency than conventional U-lamp systems having T-12 bulbs. These lamps are available in 16-, 24- and 31-watt sizes and are designed to operate on Octron ballasts available for the 2-, 3-, and 4-foot straight lamps respectively. Their medium bipin bases will fit existing sockets designed for ordinary T-12 Curvalume lamps.

The new size of the Octron Curvalume family allows for the design of more compact luminaires for a wide variety of applications. The tight-bend U-lamps have a center to center leg spacing of 1⅝" and have overall lengths of 10½" for the 16-watt, 16½" for the 24-watt and 22½" for the 31-watt lamps. When operated on rapid start magnetic ballasts, the Octron Curvalume lamps have an average rated life of 20,000 hours.

Available in the three standard Octron colors of 3100K, 3500K and 4100K, these lamps may be used in conjunction with other members of the Octron family to fit the varied requirements of a lighting installation. Octron Curvalume lamps also have a color rendering index of 75, common to other Octron lamp types. Table 2, in this bulletin describes the physical, electrical, and photometric performance data for the Octron Curvalume family of lamps.

OCTRON CURVALUME LAMP COLOR & PERFORMANCE DATA

	FB016 (16 watt)			FB024 (24 watt)		
Ordering Abbreviation	FB016/31K	FB016/35K	FB016/41K	FB024/31K	FB024/35K	FB024/41K
Sylvania Item Number	21801	21800	21802	21803	21810	21804
Correlated Color Temp.	3100K	3500K	4100K	3100K	3500K	4100K
Color Rendering Index	75	75	75	75	75	75
Initial Lumens	1250	1250	1250	2050	2050	2050

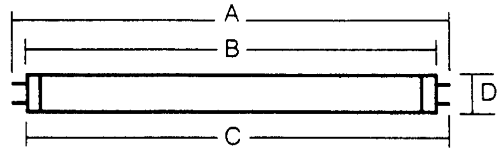
	FB031 (31 watt)		
Ordering Abbreviation	FB031/31K	FB031/35K	FB031/41K
Sylvania Item Number	21805	21807	21806
Correlated Color Temp.	3100K	3500K	4100K
Color Rendering Index	75	75	75
Initial Lumens	2800	2800	2800

EFFECT OF BURNING PERIODS ON LAMP LIFE

Due to slight variations in the lamp making process, it is impossible to have each lamp operate for exactly the life for which it was designed. For this reason, lamp life is rated as the average life of a large group of lamps, operated under controlled laboratory conditions. Average rated life is the point at which approximately 50 percent of the lamps in a large test group have burned out and 50 percent remain burning as shown in Figure 8.

During the operation of a fluorescent lamp, the emissive material is gradually depleted from the cathodes. The normal end of life is reached when there is insufficient emissive material remaining on either cathode to strike the arc. Since published average rated life figures are based on a three hour burning cycle, these ratings reflect the effects of both starting and operating. Changes in the burning cycle will affect life in service. Shorter burning cycles (more frequent starts) shorten lamp life and extended burning cycles (less frequent starts) increase lamp life. Figure 9 lists the average life in hours for Octron fluorescent lamps at various burning cycles. Data is provided for Octron lamps operated at 60Hz. in the rapid start mode as well as for high frequency operation in the instant start mode.

STRAIGHT OCTRON PERFORMANCE DATA



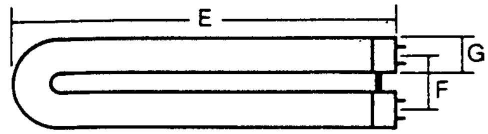
(TABLE I)

	F017		F025		F032		F040	
I. Physical Characteristics	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Overall Length (A)	23.67″	23.78″	35.67″	35.78″	47.67″	47.78″	59.50″	59.61″
Face to Face (B)		23.22″		35.22″		47.22″		59.05″
Face to End of Opposite Pin (C)	23.41″	23.50″	35.41″	35.50″	47.41″	47.50″	59.24″	59.33″
Bulb Diameter (D)	.94″	1.1″	.94″	1.10″	.94″	1.10″	.94″	1.10″
Base Type	medium bipin		medium bipin		medium bipin		medium bipin	
II. Electrical Characteristics 60 Hz Rapid Start								
Lamp								
Rated Power	17 watts		25 watts		32 watts		40 watts	
Lumens per Watt	79 LPW		86 LPW		90.6 LPW		91.3 LPW	
Lamp Current	265 ma.		265 ma.		265 ma.		265 ma.	
Lamp Voltage	73 v.		106 v.		139 v.		172 v.	
Lamp Life (3 hrs./start)	20,000 hrs.		20,000 hrs.		20,000 hrs.		20,000 hrs.	
Ballast Requirements (2-lamp)								
Starting Time	0.75-2.0 sec.		0.75-2.0 sec.		0.75-2.0 sec.		0.75-2.0 sec.	
Open Circuit Voltage[1]	210		260		300		385	
Starting Aid Voltage[1] (peak)	350		350		290		350	
Filament Voltage[1]								
Dummy Load (11 ohms)	3.4-4.5 v.		3.4-4.5 v.		3.4-4.5 v.		3.4-4.5 v.	
Operational	2.5-4.0 v.		2.5-4.0 v.		2.5-4.3 v.		2.5-4.0 v.	
Lamp Current Crest Factor	1.7 max.		1.7 max.		1.7 max.		1.7 max.	
III. Electrical Characteristics 25 KHz Instant Start								
Lamp								
Rated Power	14 watts		21 watts		28 watts		35 watts	
Lumens per Watt	97 LPW		102 LPW		103.6 LPW		104 LPW	
Lamp Current	210 ma.		210 ma.		210 ma.		210 ma.	
Lamp Voltage	66 v.		101 v.		136 v.		172 v.	
Lamp Life (3 hrs./start)	15,000 hrs.		15,000 hrs.		15,000 hrs.		15,000 hrs.	
Ballast Requirements								
Open Circuit Voltage	425 v. min.[4]		425 v. min.[4]		500 v. min.[4]		575 v. min.[4]	
Starting Time	50 ms. max.		50 ms. max.		50 ms. max.		50 ms. max.	
Current Crest Factor	1.7 max.		1.7 max.		1.7 max.		1.7 max.	
IV. Photometric Characteristics								
Ordering Abbreviation	F017/31K	F017/41K	F025/31K	F025/41K	F032/31K	F032/41K	F040/31K	F040/41K
Sylvania Item Number	21830	21831	21828	21829	21825	21824	21826	21827
Correlated Color Temp.	3100K	4100K	3100K	4100K	3100K	4100K	3100K	4100K
Color Rendering Index	75	75	75	75	75	75	75	75
Initial Lumens	1350	1350	2150	2150	2900	2900	3650	3650
Mean Lumens (8000 Hrs)[2]	1215	1215	1935	1935	2600	2600	3285	3285
Mean Lumens (6000 Hrs)[3]	1235	1235	1965	1965	2650	2650	3335	3335

1. For Starting at 50° F and above
2. Mean Lumens at 40% of 20,000 Hr rated Life—Rapid Start Operation
3. Mean Lumens at 40% of 15,000 Hr rated Life—Instant Start Operation—High Frequency
Single lamp requirement

8-35

OCTRON CURVALUME PERFORMANCE DATA



(TABLE II)

	FB016		FB024		FB031	
I. Physical Characteristics	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**
Base face to Outside of glass bend (E)	10.25″	10.60″	16.25″	16.60″	22.25″	22.60″
Center to Center of bases (F)	1.50″	1.75″	1.50″	1.75″	1.50″	1.75″
Bulb Diameter (G)	.94″	1.10″	.94″	1.10″	.94″	1.10″
Base Type	medium bipin		medium bipin		medium bipin	
II. Electrical Characteristics						
60 Hz Rapid Start						
Lamp						
Rated Power	16 watts		24 watts		31 watts	
Lumens per Watt	78 LPW		85 LPW		90 LPW	
Lamp Current	265 ma.		265 ma.		265 ma.	
Lamp Voltage	67 v.		100 v.		133 v.	
Lamp Life (3 hrs./start)	20,000 hrs.		20,000 hrs.		20,000 hrs.	
Ballast Requirements (2-lamp)						
Starting Time	.75-2.0 sec.		.75-2.0 sec.		.75-2.0 sec.	
Open Circuit Voltage[1]	210		260		300	
Starting Aid Voltage[1] (peak)	350		350		290	
Filament Voltage[1]						
Dummy Load (11 ohms)	3.4-4.5 v.		3.4-4.5 v.		3.4-4.5 v.	
Operational	2.5-4.0 v.		2.5-4.0 v.		2.5-4.0 v.	
Lamp Current Crest Factor	1.7 max.		1.7 max.		1.7 max.	
III. Electrical Characteristics						
25 KHz Instant Start						
Lamp						
Rated Power	13 watts		20 watts		27 watts	
Lumens per Watt	97 LPW		102 LPW		104 LPW	
Lamp Current	210 ma.		210 ma.		210 ma.	
Lamp Voltage	61 v.		96 v.		131 v.	
Lamp Life (3 hrs./start)	15,000 hrs.		15,000 hrs.		15,000 hrs.	
Ballast Requirements						
Open Circuit Voltage	425 v. min.[4]		500 v. min.[4]		575 v. min.[4]	
Starting Time	50 ms. max.		50 ms. max.		50 ms. max.	
Current Crest Factor	1.7 max.		1.7 max.		1.7 max.	
IV. Photometric Characteristics						
Ordering Abbreviation	FB016/31K	FB016/41K	FB024/31K	FB024/41K	FB031/31K	FB031/41K
Sylvania Item Number	21801	21802	21803	21804	21805	21806
Correlated Color Temp.	3100K	4100K	3100K	4100K	3100K	4100K
Color Rendering Index	75	75	75	75	75	75
Initial Lumens	1250	1250	2050	2050	2800	2800
Mean Lumens (8000 Hrs)[2]	1125	1125	1845	1845	2520	2520
Mean Lumens (6000 Hrs)[3]						

1. For Starting at 50° F and above
2. Mean Lumens at 40% of 20,000 Hr rated Life—Rapid Start Operation
3. Mean Lumens at 40% of 15,000 Hr rated Life—Instant Start Operation—High Frequency
4. Single lamp requirement

Sales Offices

Atlanta, Georgia
2115 Sylvan Road, S.W.
Atlanta, Georgia 30344
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Fax: 404-761-7861

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(Salem-Danvers)
60 Boston Street
Salem, Massachusetts 01970
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25 Dewberry Lane
Gardenville Ind. Park
Buffalo, New York 14224
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P.O. Box 5246
Charlotte, North Carolina 28225
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800 Devon Avenue
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Springfield, Virginia 22151
703-354-3100
Fax: 703-642-5834

SYLVANIA LIGHTING SERVICES FIXTURE CONVERSION DATA

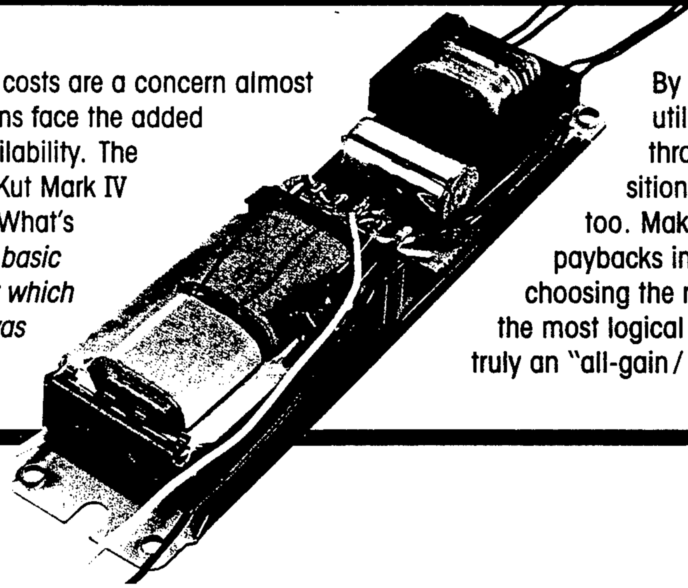
Fixtures that are "Convertible" to the Octron System	Typical Wattages after Conversion to Octron System	Typical Pre-Conversion T12 System Wattages[1]	Estimated Change in Fixture Wattage with Conversion[2]	Estimated Change in Light Output with Conversion[3]
1-F20 (2′ Fixture)	24 Watts w/Mag Ballast	32 Watts w/Std lamp	Down 25%	Up 7 – 10%
2-F20 (2′ Fixture)	43 Watts w/Mag Ballast	50 Watts w/Std lamps	Down 14%	Up 7 – 10%
3-F20 (2′ Fixture)	51 Watts w/Elec Ballasts (67 Watts w/Mag Ballast)	82 Watts w/Std lamps	Down 38%	Up 7 – 10%
4-F20 (2′ Fixture)	57 Watts w/Elec Ballast (86 Watts w/Mag Ballasts)	100 Watts w/Std lamps	Down 43%	Up 7 – 10%
1-F30 (3′ Fixture)	29 Watts w/Mag Ballast	43 Watts w/Std lamp 36 Watts w/SS lamp	Down 33% Down 20%	No Change Up 7 – 10%
2-F30 (3′ Fixture)	48 Watts w/Elec Ballast (55 Watts w/Mag Ballast)	75 Watts w/Std lamps 61 Watts w/SS lamps	Down 36% Down 21%	No Change Up 7 – 10%
3-F30 (3′ Fixture)	64 Watts w/Elec Ballast (84 Watts w/Mag Ballasts)	118 Watts w/Std lamps 97 Watts w/SS lamps	Down 46% Down 34%	No Change Up 7 – 10%
4-F30 (3′ Fixture)	84 Watts w/Elec Ballast (110 Watts w/Mag Ballasts)	150 Watts w/Std lamps 122 Watts w/SS lamps	Down 44% Down 31%	No Change Up 7 – 10%
1-F40 (4′ Fixture)	35 Watts w/Mag Ballast	55 Watts w/Std lamp 48 Watts w/SS lamp	Down 36% Down 27%	No Change Up 10 – 14%
2-F40 (4′ Fixture)	62 Watts w/Elec Ballast (67 Watts w/Mag Ballast)	92 Watts w/Std lamps 78 Watts w/SS lamps	Down 33% Down 21%	No Change Up 10 – 14%
3-F40 (4′ Fixture)	84 Watts w/Elec Ballast (102 Watts w/Mag Ballasts)	147 Watts w/Std lamps 126 Watts w/SS lamps	Down 43% Down 33%	No Change Up 10 – 14%
4-F40 (4′ Fixture)	106 Watts w/Elec Ballast (133 Watts w/Mag Ballasts)	174 Watts w/Std lamps 156 Watts w/SS lamps	Down 39% Down 32%	No Change Up 10 – 14%
2-FB40 (2′ x 2′ Fixture)	60 Watts w/Elec Ballast (65 Watts w/Mag Ballast)	92 Watts w/Std lamps 78 Watts w/SS lamps	Down 35% Down 23%	No Change Up 10 – 14%

NOTES:

1. Estimate is based on fixtures with Standard Magnetic Ballasts
2. Compared to lowest wattage Octron system
3. Assumes same age of both old & new systems (4100K vs. CW). Does not consider immediate light level improvement provided by relamping.

A Solid Choice for Many Applications

Rapidly rising electrical power costs are a concern almost everywhere. And some locations face the added problem of limited power availability. The energy-saving ADVANCE PowrKut Mark IV ballast is an answer for both. What's more, it lets you *maintain the basic lighting performance levels for which your present lighting system was originally designed*.

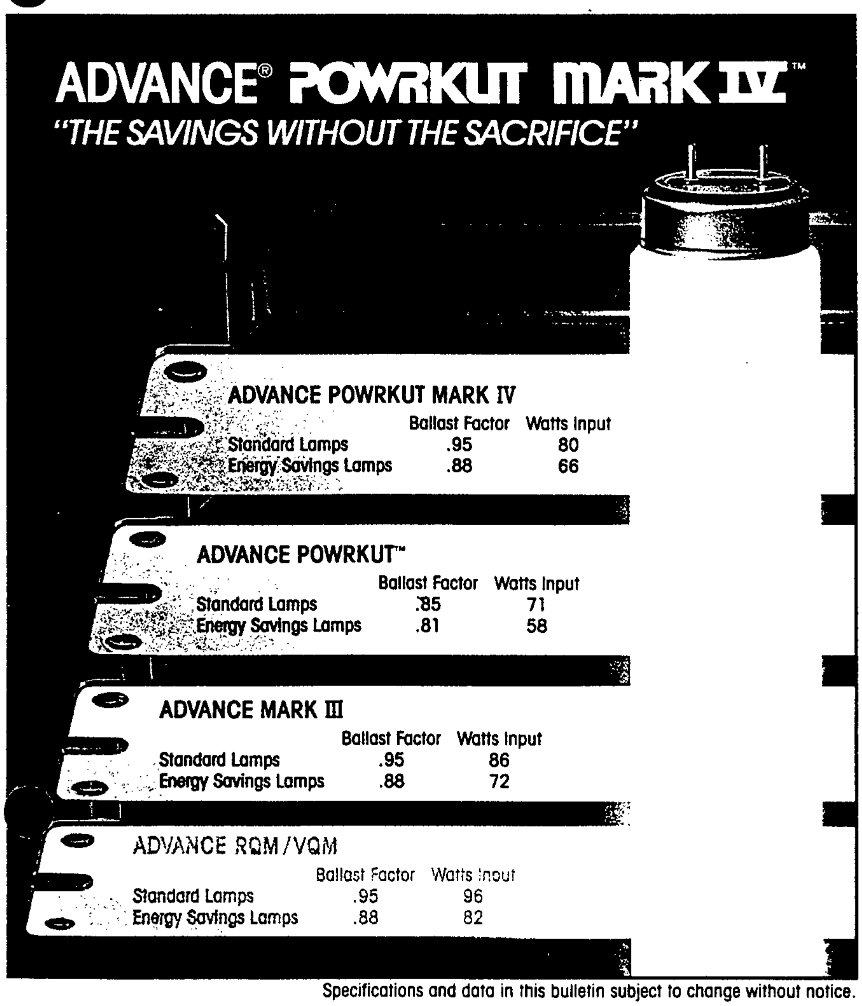


By taking advantage of the extensive utility rebate programs available throughout many areas, your acquisition cost may be greatly reduced, too. Making for one of the fastest overall paybacks in ballasting today. Indeed, choosing the new PowrKut Mark IV may be the most logical move you've ever made – it's truly an "all-gain / no-pain" proposition.

ADVANCE® PowrKut Mark IV™ Ballast for Two 4-ft. F-40 Rapid Start Lamps—60 Hz

Lamp Data		Min. Starting Temp. (°F)	Ballast Input Watts	Line Current (Amps)	Circuit (Volts)	Catalog Number (Class P)	Ballast Efficacy Factor	Sound Rating	Dimensions (Inches)				No. of Units Per Std. Ctn.	Wt. Std. Ctn. (Lbs.)
Description	Nom. Watts								Length	Width	Height	Mounting		
(2) F40 (2) F40/U Energy Savers	34	60°	66	.57 .26	120 277	RK-2S40-TPⒺ VK-2S40-TPⒺ	1.33	A	9½	2⅜	1½	8 29/32	10	38.
(2) F40T12, (2) F40T10, (2) FB40T12	40	50°	80	.69 .31	120 277	RK-2S40-TPⒺ VK-2S40-TPⒺ	1.16							

ETL verification of performance to specifications in ETL Procedure B30.0 with test methods per ANSI Standard C82.2.

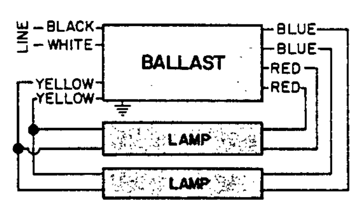


Specifications—ADVANCE PowrKut Mark IV Hybrid Electromagnetic Ballast

The ballast shall be ADVANCE PowrKut Mark IV hybrid electromagnetic design incorporating special circuitry to cut off cathode voltage to lamp filaments after the lamps are lit. It shall have an average input of 80 watts when operating 2, F40T12 (40W) rapid start lamps with ballast factor of .95 and average input of 66 watts when operating 2, F40T12 (34W) energy saving rapid start lamps with ballast factor of .88. Performance verified by ETL Laboratories to specifications in ETL Procedural Guide B30.0, using Test Methods of ANSI C82.2.

When operating 2, F40T12 (40W) rapid start lamps, Ballast Efficacy Factor (B.E.F.) shall meet or exceed 1.16; lamp current crest factor shall not exceed 1.6. Ballast shall have a 3-year warranty; design shall provide full rated 20,000 hour lamp life.

Wiring Diagram



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Specifications and data in this bulletin subject to change without notice.

Form No. 1516 Printed in U.S.A.

EBT LOW HARMONIC BALLAST GUIDE

RAPID START BALLAST (SERIES CONNECTION)

LAMPS	LAMP TYPE	LAMP LENGTH	LAMP WATTS	INPUT VOLTAGE	LINE AMPS	INPUT WATTS	ORDERING CODE
1 ***	F40T12/RS	4'	34	120	0.27	31	SSB1-120-1/40 LH
			40		0.33	38	
			34	277	0.12	31	SSB1-277-1/40 LH
			40		0.14	38	
2 ***	F40T12/RS	4'	34	120	0.50	59	SSB1-120-2/40 LH
			40		0.60	71	
			34	277	0.22	59	SSB1-277-2/40 LH
			40		0.26	71	
3 ***	F40T12/RS	4'	34	120	0.77	90	SSB1-120-3/40 LH
			40		0.89	105	
			34	277	0.33	90	SSB1-277-3/40 LH
			40		0.39	105	
2 ****	F96T12/HO	8'	95	120	1.36	160	SSB1-120-2/96 HO LH
			110		1.62	190	
			95	277	0.59	160	SSB1-277-2/96 HO LH
			110		0.70	190	

INSTANT START BALLAST (PARALLEL CONNECTION)

1	FO32T8	4'	32	120	0.26	30	SSB2-120-1/32 IS LH
			32	277	0.11	30	SSB2-277-1/32 IS LH
2 *	FO32T8	4'	32	120	0.49	58	SSB2-120-2/32 IS LH
	FO40T8	5'	40		0.59	70	
	FO32T8	4'	32	277	0.21	58	SSB2-277-2/32 IS LH
	FO40T8	5'	40		0.26	70	
3 ***	FO32T8	4'	32	120	0.75	88	SSB2-120-3/32 IS LH
	FO32T8	4'	32	277	0.32	88	SSB2-277-3/32 IS LH
4	FO32T8	4'	32	120	0.90	106	SSB2-120-4/32 IS LH
	FO32T8	4'	32	277	0.39	106	SSB2-120-4/32 IS LH
2 *****	F96T12/IS	8'	60	120	0.89	105	SSB2-120-2/96 IS LH
			75		1.11	130	
			60	277	0.39	105	SSB2-277-2/96 IS LH
			75		0.48	130	
2	40W (TWIN TUBE)	22.5"	40	120	0.55	65	SSB2-120-2/40 IS LH TT
		22.5"	40	277	0.24	65	SSB2-277-2/40 IS LH TT
3	40W (TWIN TUBE)	22.5"	40	120	0.86	101	SSB2-120-3/40 IS LH TT
		22.5"	40	277	0.37	101	SSB2-277-3/40 IS LH TT

* ALSO COMPATIBLE WITH FO25T8 LAMPS

** ALSO COMPATIBLE WITH FO40T8 LAMPS

*** ALSO COMPATIBLE WITH F30T12, OR F25T12 LAMPS

**** ALSO COMPATIBLE WITH F72T12/HO OR F84T12/HO LAMPS

***** ALSO COMPATIBLE WITH F60T12, F70T12 OR F84T12 LAMPS

EBT SPECIAL PRODUCT GUIDE

LAMPS	LAMP TYPE	LAMP LENGTH	LAMP WATTS	INPUT VOLTAGE	LINE AMPS	INPUT WATTS	ORDERING CODE
2 *	F40T12/RS	4'	34	120	0.53	59	SSB1-120-2/40 MINI
			40		0.64	71	
			34	277	0.23	59	SSB1-277-2/40 MINI
			40		0.28	71	
2 **	F032T8/RS	4'	32	120	0.58	64	SSB1-120-2/32 MINI
			32	277	0.25	64	SSB1-277-2/32 MINI
2 **	F032T8/RS	4'	32	120	0.53	62	SSB1-120-2/32 LH
			32	277	0.23	62	SSB1-277-2/32 LH
3	F032T8/RS	4'	32	120	0.80	94	SSB1-120-3/32 LH
			32	277	0.35	94	SSB1-277-3/32 LH
2	F017T8/RS	2'	17	120	0.29	34	SSB2-120-2/17 IS
			17	277	0.12	34	SSB2-277-2/17 IS
2 *	F40T12/RS	4'	34	120	0.60	71	SSB1-120-2/40MPX LH
			40		0.73	86	
			34	277	0.26	71	SSB1-277-2/40MPX LH
			40		0.32	86	
2 *	F40T12/RS	4'	34	120	0.56	66	SSB1-120-2/40 LH 100%
			40		0.68	80	
			34	277	0.24	66	SSB1-277-2/40 LH 100%
			40		0.29	80	

* ALSO COMPATIBLE WITH F40T12/32W, F30T12, F25T12, 3" AND 6" "U" TUBE LAMPS

** ALSO COMPATIBLE WITH F025T8, F032T8 LAMPS

The ballast total harmonic distortion level may not be less than 20% when used with the above compatible lamps.

RS&H®

SUBJECT	ECO 10 Energy Efficient Motors	AEP NO	290-0379-002
DESIGNER	C. Warren	SHEET	1 OF
CHECKER	R. Hutchins	DATE	7/9/91
		DATE	

Bldg 35

Replace motors in small parts plating line and medium tube plating line w/ energy-efficient ones.

Assumptions:

1. Consider motors for fans, pumps, blowers $\geq$ 3 HP

2. Motors run 24 HR/DA, 7 DA/WK, 52 WK/YR, MED TUBE PLATING

   ⇒ 8760 HRS/YR

   RUN 24 HR/DA, 5 DA/WK, 52 WK/YR, SMALL PARTS PLATING

   ⇒ 6240 HRS/YR

3. Labor charges are doubled to account for old motor removal time

Calculations

Preliminary screening calculation using spreadsheet on following page (10-2). Material costs from Reliance 1991 catalog - labor from 1991 Means

⇒ Consider motors $\leq$ 100 HP only

ECO #10 - WATERVLIET ARSENAL
INSTALL ENERGY EFFICIENT MOTORS
FILENAME: REPEEM
DATE: 29 AUG 91   OPERATING HOURS =   6000

	LIST PRICE	CONTRACTOR	LABOR	MAT'L & LABOR	EFFICIENCES				
MOTOR SIZE (HP)	RELIANCE ENERGY-EFF. ENCLOSED (1991$)	RELIANCE ENERGY-EFF. ENCLOSED (1991$)	REMOVE OR INSTALL MOTOR (1991$)	PRICE W/ MARKUPS (1991$)	RELIANCE STD MOTOR NOM. EFF. (%)	RELIANCE ENERGY-EFF. ENCLOSED (%)	ENERGY SAVINGS (KWH/YR)	COST SAVINGS ($/YR)	SIMPLE PAYBACK (YRS)
3	395	296	45	609	77.0%	87.5%	2093	142	4.3
5	478	359	45	703	81.3%	88.5%	2256	153	4.6
8	636	477	48	892	82.0%	89.8%	3556	241	3.7
10	795	596	50	1079	84.0%	90.2%	3663	248	4.3
15	1042	782	63	1406	84.8%	90.9%	5360	363	3.9
20	1345	1009	77	1799	85.8%	91.7%	6774	459	3.9
25	1608	1206	80	2107	86.3%	92.3%	8504	576	3.7
30	1905	1429	84	2457	88.0%	92.7%	7737	524	4.7
40	2563	1922	100	3259	88.0%	93.3%	11557	783	4.2
50	3207	2405	125	4077	89.3%	93.3%	10745	728	5.6
60	4487	3365	145	5596	89.3%	93.1%	12444	843	6.6
75	5820	4365	170	7193	90.3%	94.0%	14839	1005	7.2
100	7140	5355	225	8884	90.6%	94.5%	20389	1382	6.4
125	9275	6956	285	11514	92.3%	94.9%	16608	1125	10.2
150	10942	8207	335	13579	91.7%	95.1%	26176	1774	7.7
200	12961	9721	400	16096	93.0%	95.1%	21256	1440	11.2
250	16652	12489	450	20448	93.6%	95.4%	22557	1528	13.4
300	17748	13311	500	21868	94.1%	95.6%	22390	1517	14.4

ASSUMPTIONS: CONTRACTORS DISCOUNT FACTOR = 0.65 FOR STANDARD DUTY, 0.75 FOR ENERGY EFFICIENT
MOTORS ARE TOTALLY ENCLOSED,T-FRAME, 1800 RPM, 460 VOLT, 3 PHASE
SAVINGS = HP * 0.746*[(1/ST EFF)-(1/EN EFF)] * HRS/YR * ELECOST
OPERATING TIMES: 24 HR/DA
5 DA/   6000 HRS/YR
ELECTRICITY COST: AVERAGE OF ENERGY & DEMAND CHARGES $0.0678 /KWH

3/92

SUBJECT	ECO 10 Energy Efficient Motors	AEP NO	290-0379-002
DESIGNER	J. Warren	SHEET	OF
CHECKER		DATE	
		DATE	

- Motor list taken from WVA Property Records

  WV 12110 - Small parts plating

  WV 12050 - Medium tube plating

- KW (SAVINGS) = HP * 0.746 * (1/STD EFFICIENCY - 1/ENERGY EFFICIENCY)

- AVG ELECT COST = $20.35 / MBtu

8/92

WATERVLIET ARSENAL
ECO#10 - INSTALL ENERGY EFFICIENT MOTORS

WV 12110 SMALL PARTS PLATING

			PRESENT METHOD			FUTURE METHOD				
			ENERGY USE			ENERGY USE			SAVINGS	
NO.	HP	HP	(KW)	(MBTU/YR)	($/YR)	(KW)	(MBTU/YR)	($/YR)	(MBTU/YR)	($/YR)
3	3	9	8.7	186	$3,779	7.7	163	$3,326	22	$453
3	5	15	13.8	293	$5,969	12.6	269	$5,480	24	$489
3	7.5	22.5	20.5	436	$8,871	18.7	398	$8,101	38	$771
11	10	110	97.7	2,081	$42,339	91.0	1,938	$39,429	143	$2,910
1	15	15	13.2	281	$5,722	12.3	262	$5,335	19	$387
1	20	20	17.4	371	$7,541	16.3	347	$7,052	24	$489
4	25	100	86.5	1,842	$37,486	80.8	1,721	$35,029	121	$2,457
2	30	60	50.9	1,083	$22,044	48.3	1,028	$20,926	55	$1,118
5	40	200	169.5	3,611	$73,480	159.9	3,406	$69,306	205	$4,174
2	60	120	100.3	2,136	$43,471	96.2	2,048	$41,673	88	$1,798
35		672	578.5	12,320	$250,702	543.7	11,580	$235,656	739	$15,046

WV 12050 MEDIUM TUBE PLATING

			PRESENT METHOD			FUTURE METHOD				
			ENERGY USE			ENERGY USE			SAVINGS	
NO.	HP	TOTAL HP	(KW)	(MBTU/YR)	($/YR)	(KW)	(MBTU/YR)	($/YR)	(MBTU/YR)	($/YR)
4	3	12	8.7	261	$5,305	7.7	229	$4,669	31	$637
6	5	30	27.5	824	$16,759	25.3	756	$15,386	67	$1,373
4	7.5	30	27.3	816	$16,605	24.9	745	$15,163	71	$1,442
2	15	30	26.4	790	$16,067	24.6	736	$14,980	53	$1,087
12	20	240	208.8	6,242	$127,034	195.2	5,837	$118,792	405	$8,243
3	40	120	101.7	3,041	$61,893	95.9	2,869	$58,377	173	$3,516
1	60	60	50.2	1,499	$30,513	48.1	1,437	$29,251	62	$1,262
32		522	450.6	13,473	$274,176	421.8	12,610	$256,617	863	$17,559

TOTALS

67		1193.5	1,029	25,793	$524,879	966	24,190	$492,273	1,602	$32,605

ELECTRICITY PRICE = $20.35 /MBTU
OPERATING HOURS PER YEAR MEDIUM TUBE PLATING = 8760
SMALL PARTS PLATING = 6240

3/92

02/05/92

ECO Construction Cost Estimate
Calculations

ECO Name: ENERGY EFFICIENT MOTORS

ECO #: 10

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$63,817
Labor	$9,038
Subtotal bare costs	$72,855
FICA Insurance (20% of Labor)	$1,808
Sales Tax (not applicable for GOGO)	$0
Subtotal	$74,663
Overhead (15%)	$11,199
Subtotal	$85,862
Profit (10%)	$8,586
Subtotal	$94,448
Bond (1%)	$944
Subtotal	$95,392
Contingency (10%)	$9,539
Subtotal (Construction Cost Input For LCCID *)	$104,931
SIOH (6% of Construction Cost)	$6,296
Subtotal	$111,227
Design (6% of Construction Cost)	$6,296
Total Project Cost	$117,523

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED 9-6-91

SHEET 1 OF

PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
WVA

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR C. WARREN

CHECKED BY R. Hutchins

SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
MOTORS WV12110 SMALL PARTS PLATING							
HP							
3	3		90	270	296	889	1159
5	3		90	270	359	1076	1346
7.5	3		96	288	477	1431	1719
10	11		100	1100	596	6559	7659
15	1		126	126	782	782	908
20	1		154	154	1009	1009	1163
25	4		160	640	1206	4824	5464
30	2		168	336	1429	2858	3194
40	5		200	1000	1922	9611	10611
60	2		290	580	3365	6731	7311
	35			4764		35768	40,532
WV 12050							
MED. TUBE PLATING							
3	4		90	360	296	1184	1544
5	6		90	540	359	2154	2694
7.5	4		96	384	477	1908	2292
15	2		126	252	782	1564	1816
20	12		154	1848	1009	12108	13956
40	3		200	600	1922	5766	6366
60	1		290	290	3365	3365	3655
	32			4274		28049	32323
TOTALS —	67			9,038		63,817	72,855

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—516140

ECO #12

Replace Electric Boilers with Natural Gas Boilers

- The electric boilers located in Buildings 40, 44, 125N and 125S are used for humidification purposes. The boiler sizes are 90 KW, 210 KW, 58 KW and 58 KW, respectively.

By replacing these boilers with boilers that utilize natural gas the cost for energy to humidify this building will be reduced by over \$15 per mBtu.

The annual hours that humidification is required was calculated by a spreadsheet computer program. the results are shown on page 3. Assuming an operating diversity of 0.30, the boilers will operate:

$$5862 \text{ hrs/yr} \times 0.30 = 1759 \text{ hrs/year}$$

Current energy use (Electricity):

$$416 \text{ KW} \times 1759 \frac{\text{Hrs}}{\text{yr}} = 731{,}744 \text{ KWH/year}$$

$$731{,}744 \text{ KWH/yr} \times 3413 \frac{\text{Btuh}}{\text{KWH}} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = \underline{2497.4 \text{ mBtu/yr}}$$

Future energy use (Natural Gas):

$$2497.4 \text{ mBtu/yr} \div 0.80 \text{ (eff.)} = \underline{3121.8 \text{ mBtu/yr}}$$

RS&H

SUBJECT WVA - Bldgs. 40, 44 & 125
Replace Electric Boilers
DESIGNER W. T. Todd
CHECKER

AEP NO 290-0379-002
SHEET 2 OF
DATE 1-31-92
DATE

The Future energy use calculation assumes the same output will be required and the efficiency of the N.G. boiler is 80%.

Energy Savings = Current energy use - Future energy use

Electricity Savings = $2497.4 \frac{mBtu}{Yr} - 0 = \underline{2497.4 \frac{mBtu}{Yr}}$.

Natural Gas Savings = $0 - 3121.8 \frac{mBtu}{Yr} = \underline{(3121.8) \frac{mBtu}{Yr}}$

Total Savings:

Energy: $2497.4\ mBtu/Yr - 3121.8\ mBtu/Yr = \underline{(624.4)\ mBtu/Yr}$

Project Implementation Cost:

Total Project Cost = $\underline{\$49,944}$

See Cost Estimate Sheets for details

RS&H®

SUBJECT ECO #12

AEP NO

SHEET ______ OF ______

DESIGNER

DATE

CHECKER

DATE

QRIP Calculations

Present Method

Elec = 2497.4 MBTU/yr * $20.35/MBTU = $50,800

Proposed Method

N. Gas = 3121.8 MBTU/yr * $4.16/MBTU = $13,000

Savings = $37,800

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 01/31/92

INPUTS:
1) Days Per Week That HVAC Operates — 7 Days/Week
2) Summer Room Dry Bulb Temperature — 75 'F (db)
   Room Wet Bulb Temperature — 63 'F (wb)
3) Winter Room Dry Bulb Temperature — 68 'F (db)
   If RH Controlled, wb Temp. — 57 'F (wb)
   and Ground Water Temperature — 50 'F
4) Outside Air Quantity (cfm) — 1 cfm
5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM — 8 Hrs/Shift
   8 AM -> 4 PM — 8 Hrs/Shift
   4 PM -> 12 M — 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24	Hours	Cooling	Dehumid	Heating	Humid.
120	124					0	0.0000	0.0000	0.0000	0.0000
115	119					0	0.0000	0.0000	0.0000	0.0000
110	114					0	0.0000	0.0000	0.0000	0.0000
105	109					0	0.0000	0.0000	0.0000	0.0000
100	104					0	0.0000	0.0000	0.0000	0.0000
95	99	75	0	7	0	7	0.0002	0.0001	0.0000	0.0000
90	94	72	0	28	6	34	0.0006	0.0004	0.0000	0.0000
85	89	71	0	95	28	123	0.0016	0.0018	0.0000	0.0000
80	84	68	4	177	73	254	0.0020	0.0024	0.0000	0.0000
75	79	66	27	248	140	415	0.0009	0.0032	0.0000	0.0000
70	74	64	115	257	222	594	0.0000	0.0039	0.0000	0.0000
65	69	61	234	235	271	740	0.0000	0.0019	0.0000	0.0000
60	64	57	263	212	252	727	0.0000	0.0000	0.0048	0.0000
55	59	52	274	190	236	700	0.0000	0.0000	0.0085	0.0009
50	54	48	263	183	214	660	0.0000	0.0000	0.0116	0.0036
45	49	43	242	183	205	630	0.0000	0.0000	0.0146	0.0069
40	44	38	229	202	205	636	0.0000	0.0000	0.0182	0.0099
35	39	34	261	241	251	753	0.0000	0.0000	0.0257	0.0133
30	34	30	295	220	262	777	0.0000	0.0000	0.0308	0.0152
25	29	25	216	156	191	563	0.0000	0.0000	0.0254	0.0128
20	24	20	163	112	130	405	0.0000	0.0000	0.0205	0.0103
15	19	16	110	79	96	285	0.0000	0.0000	0.0160	0.0074
10	14	11	84	43	65	192	0.0000	0.0000	0.0118	0.0053
5	9	6	60	27	38	125	0.0000	0.0000	0.0084	0.0036
0	4	2	37	16	22	75	0.0000	0.0000	0.0054	0.0022
-5	-1	-3	27	3	9	39	0.0000	0.0000	0.0030	0.0012
-10	-6	-8	10	0	4	14	0.0000	0.0000	0.0012	0.0004
-15	-11	-13	5	0	0	5	0.0000	0.0000	0.0004	0.0002
-20	-16	-17	3	0	0	3	0.0000	0.0000	0.0003	0.0001
-25	-21					0	0.0000	0.0000	0.0000	0.0000
-30	-26					0	0.0000	0.0000	0.0000	0.0000
-35	-31					0	0.0000	0.0000	0.0000	0.0000
-40	-36					0	0.0000	0.0000	0.0000	0.0000
-45	-41					0	0.0000	0.0000	0.0000	0.0000
Totals			2922	2914	2920	8756	0.0053	0.0138	0.2066	0.0935
Total operating hours for each system							833	2167	6589	5862

CONSTRUCTION COST ESTIMATE

DATE PREPARED 1-31-92

SHEET 4 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WATERVLIET ARSENAL

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS

BASIS FOR ESTIMATE
- [X] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR: W. T. Todd

CHECKED BY

Pg #	Replace Ele. Boiler Bldgs. 40 & 125 SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
151 M	320 MBH Gas-Fired Boiler	1	EA	1125	1125	2640	2640	3765
151 M	203 MBH Gas-Fired Boiler	2	EA	865	1730	1840	3680	5410
158 M	Automatic Flue Damper	3	EA	17	51	118	354	405
184 M (1)	6"Ø Gal. Steel Flue Chimney	90	VLF	7.20	648	5.00	450	1098
38 M (2)	Sch. 40 Black Steel Pipe	300	LF	7.20	2160	3.98	1194	3354
162 E	Electric Switching	3	EA	91	273	485	1455	1728
185 M	6"Ø Roof Flashing	3	EA	12	36	9	27	63
(3)	Remove Exist. Boiler	3	EA	400	1200	-0-	-0-	1200
201 M	Pressure Regulator	3	EA	18.55	56	389	1167	1223
	Subtotal				$7,279		$10,967	$18,246

Source: Means Mechanical Cost Data, 1991
Means Electrical Cost Data, 1991

(1) 20% added for fittings, includes rain cap.

(2) Includes Hangars, 20% added for Fittings

(3) 2 men at $25 per hour for 2 days

ENG FORM 150
1 AUG 59

(ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

CONSTRUCTION COST ESTIMATE	DATE PREPARED 2-5-92	SHEET 5 OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WATERVLIET ARSENAL

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS

BASIS FOR ESTIMATE:
- ☒ CODE A (No design completed)
- ☐ CODE B (Preliminary design)
- ☐ CODE C (Final design)
- ☐ OTHER (Specify)

DRAWING NO.:

ESTIMATOR: W. T. Todd

CHECKED BY:

	Replace Elec. Boiler Building 44 SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
		NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
M151	765 MBH Gas-fired Boiler	1	EA	1725	1725	5740	5740	7465
M158	Automatic Flue Damper	1	EA	18	18	128	128	146
M134 (1)	8"Ø Gal. Steel Flue chimney	30	VLF	8.28	249	8.21	247	496
M88 (2)	Sch. 40 Blk. Steel Pipe	50	LF	7.20	360	3.98	199	559
M101	Pressure Regulator	1	EA	18.55	19	389	389	408
M185	8"Ø Roof Flashing	1	EA	13.85	14	12.40	13	27
162	Electric Switching	1	EA	91	91	485	485	576
(3)	Remove Exist. Boiler	1	EA	400	400	-0-	-0-	400
M18	Excavate & Backfill Trench, 8"	150	LF	0.21	32	0.17	26	58
M22 (2)	Sch. 40 Steel, Coated Pipe	155	LF	3.34	518	4.21	653	1171
M20	Crushed Stone Bedding, 6"	2	CY	3.01	6	14.17	29	35
	Subtotal				$3,432		$7,909	$11,341

Source: Means Mechanical Cost Data, 1991
Means Electrical Cost Data, 1991

(1) 20% added for fittings, includes rain cap

(2) Includes Hangars, 20% added for fittings

(3) 2 men at $25 per hour for 2 days

ENG FORM 150, 1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

02/05/92

ECO Construction Cost Estimate Calculations

ECO Name: Replace Electric Boilers with Natural Gas Boilers

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$18,876
Labor		$10,711
	Subtotal bare costs	$29,587
FICA Insurance (20% of Labor)		$2,142
Sales Tax (Not Applicable For GOGO)		$0
	Subtotal	$31,729
Overhead (15%)		$4,759
	Subtotal	$36,488
Profit (10%)		$3,649
	Subtotal	$40,137
Bond (1%)		$401
	Subtotal	$40,538
Contingency (10%)		$4,054
Subtotal (Construction Cost Input For LCCID *)		$44,592
SIOH (6.0% of Construction Cost)		$2,676
	Subtotal	$47,268
Design (6.0% of Construction Cost)		$2,676
Total Project Cost		$49,944

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

RS&H

SUBJECT WVA - Building 120
Reduce Air Flow - AHU 1
DESIGNER W. T. Todd
CHECKER

AEP NO 290-0379-002
SHEET 1 OF 8
DATE 12-24-91
DATE

ECO #13

Reduce Air Flow from AHU 1

The design air flow based on the "As Built" drawings is 6250 cfm, with a minimum of 930 cfm of outdoor air.

Measurements were taken on the supply air ducts. The calculations to determine the air flow were done on a spreadsheet and the results are displayed on page 13-4. The results indicate the total supply air flow for AHU 1 to be approximately 8230 cfm, an increase of 1980 cfm over the design value.

It is assumed that the minimum outdoor air flow is now higher than the design amount by the same percentage:

$$\frac{\text{Min. O.A.}}{8250 \text{ cfm}} = \frac{930 \text{ cfm}}{6250 \text{ cfm}} = 0.149$$

$$\text{Min. O.A.} = 1225 \text{ cfm}$$

The excess O.A. must be heated in the winter and cooled in the summer. The energy required to do this was calculated using a spreadsheet computer program with bin temperatures and the following equation:

$$Q_s(\text{mBtu/Yr}) = \text{Hrs/Yr} * 1.10 * \text{O.A. CFM} * \Delta T$$

$$Q_L(\text{mBtu/Yr}) = \text{Hrs/Yr} * 0.69 * \text{O.A. CFM} * \Delta W$$

The results are shown on pages 13-5 and 13-6.

Current energy use (using COP = 3.23, Boiler eff = 0.80):

Cooling : $11.83 \frac{mBtu}{yr} \times 0.31 = \underline{3.7 \ mBtu/yr}$, Electricity

Heating : $82.49 \frac{mBtu}{yr} \div 0.80 = \underline{103.1 \ mBtu/yr}$, Fuel Oil #6

Fan : $7.0 \ A \times 480 \ V \times 1.47 \times \frac{1 \ kw}{1000 \ V \cdot A} = 4.9 \ kw$

$4.9 \ kw \times 3125 \ hr/yr \times \frac{0.003413 \ mBtu}{kWH} = \underline{52.3 \frac{mBtu}{yr}}$, Electricity

Future energy use:

Cooling : $8.98 \frac{mBtu}{yr} \times 0.31 = \underline{2.8 \frac{mBtu}{yr}}$, Electricity

Heating : $62.62 \frac{mBtu}{yr} \div 0.80 = \underline{78.3 \frac{mBtu}{yr}}$, Fuel oil #6

Fan : $\frac{cfm_1}{cfm_2} = \frac{rpm_1}{rpm_2} \Rightarrow \frac{6250}{8320} = \frac{Rpm_1}{997} \Rightarrow Rpm_1 = 749$

$\frac{P_1}{P_2} = \left(\frac{rpm_1}{rpm_2}\right)^3 \Rightarrow \frac{P_1}{7A} = \left(\frac{749}{997}\right)^3 \Rightarrow P_1 = 3.0 \ A$

$3.0 \ A \times 480 \ V \times 1.47 \times \frac{1 \ kw}{1000 \ V \cdot A} = 2.1 \ kw$

$2.1 \ kw \times 3125 \ hr/yr \times \frac{0.003413 \ mBtu}{kWH} = \underline{22.4 \frac{mBtu}{yr}}$, Electricity

Energy Savings = Current energy use - Future energy use

RS&H®

SUBJECT ECO # 13

DESIGNER

CHECKER

AEP NO

SHEET ____ OF ____

DATE

DATE

QRIP Calculations.

Present Method Cost

Elec. : $= (3.7 + 52.3)$ MBTU/yr * $\frac{\$20.35}{MBTU}$ = $1140

#6 F.O. : = 103.1 MBTU/yr * $\frac{\$4.40}{MBTU}$ = 454

TOTAL $1600

Proposed Method Cost

Elec = (2.8 + 22.4) * 20.35 = $ 513

#6 F.O. = 78.3 * 4.4 = 345

TOTAL $ 860

Savings = 1600 - 860 = $740/yr

Electrictity Savings:

Cooling : 3.7 mBtu/yr - 2.8 mBtu/yr = 0.9 mBtu/yr

Fan : 52.3 mBtu/yr - 22.4 mBtu/yr = 29.9 mBtu/yr

Total : 0.9 mBtu/yr + 29.9 $\frac{\text{mBtu}}{\text{yr}}$ = 30.8 mBtu/yr

Fuel Oil #6 Savings

Heating : 103.1 mBtu/yr - 78.3 mBtu/yr = 24.8 mBtu/yr

Total Savings:

Energy : 30.8 mBtu/yr + 24.8 mBtu/yr = 55.6 mBtu/yr

Project Implementation Cost:

Total Project Cost = \$ 1,024

See cost estimate sheets for details

Watervliet Arsenal - Energy Study 12/24/91
Filename: B120AHU1.WQ1

Building 120
AHU 1 Analysis

Zone	Measured P(v)	Velocity FPM	Duct Size in x in		Area SqFt	Measured CFM	Design CFM	CFM Diff.
1	0.1007	1271	14	14	1.36	1730	1240	490
2	0.0467	865	14	16	1.56	1346	1200	146
3	0.1039	1291	10	18	1.25	1614	1000	614
4	0.0162	510	10	14	0.97	496	600	-104
5	0.0294	687	10	14	0.97	668	700	-32
6	0.1167	1368	8	10	0.56	760	450	310
7	0.1542	1573	8	10	0.56	874	360	514
8	0.0343	742	12	12	1.00	742	700	42
					Totals	8230	6250	1980

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 01/31/92

INPUTS:		
1)	Days Per Week That HVAC Operates	5 Days/Week
2)	Summer Room Dry Bulb Temperature	75 °F (db)
	Room Wet Bulb Temperature	63 °F (wb)
3)	Winter Room Dry Bulb Temperature	68 °F (db)
	If RH Controlled, wb Temp	· °F (wb)
	and Ground Water Temperature	°F
4)	Outside Air Quantity (cfm)	1225 cfm
5)	HVAC Oper. Hrs/Shft: 12 M -> 8 AM	2 Hrs/Shift
	8 AM -> 4 PM	8 Hrs/Shift
	4 PM -> 12 M	2 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper.	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24	Hours	Cooling	Dehumid	Heating	Humid.
120	124					0	0.0000	0.0000	0.0000	0.0000
115	119					0	0.0000	0.0000	0.0000	0.0000
110	114					0	0.0000	0.0000	0.0000	0.0000
105	109					0	0.0000	0.0000	0.0000	0.0000
100	104					0	0.0000	0.0000	0.0000	0.0000
95	99	75	0	7	0	5	0.1482	0.1213	0.0000	0.0000
90	94	72	0	28	6	21	0.4827	0.3402	0.0000	0.0000
85	89	71	0	95	28	73	1.1781	1.3278	0.0000	0.0000
80	84	68	4	177	73	140	1.3222	1.5936	0.0000	0.0000
75	79	66	27	248	140	207	0.5578	1.9769	0.0000	0.0000
70	74	64	115	257	222	244	0.0000	1.9728	0.0000	0.0000
65	69	61	234	235	271	258	0.0000	0.8036	0.0000	0.0000
60	64	57	263	212	252	243	0.0000	0.0000	1.9678	0.0000
55	59	52	274	190	236	227	0.0000	0.0000	3.3615	0.0000
50	54	48	263	183	214	216	0.0000	0.0000	4.6547	0.0000
45	49	43	242	183	205	211	0.0000	0.0000	5.9576	0.0000
40	44	38	229	202	205	222	0.0000	0.0000	7.7703	0.0000
35	39	34	261	241	251	264	0.0000	0.0000	11.0100	0.0000
30	34	30	295	220	262	257	0.0000	0.0000	12.4480	0.0000
25	29	25	216	156	191	184	0.0000	0.0000	10.1715	0.0000
20	24	20	163	112	130	132	0.0000	0.0000	8.2019	0.0000
15	19	16	110	79	96	93	0.0000	0.0000	6.4059	0.0000
10	14	11	84	43	65	57	0.0000	0.0000	4.3255	0.0000
5	9	6	60	27	38	37	0.0000	0.0000	3.0237	0.0000
0	4	2	37	16	22	22	0.0000	0.0000	1.9534	0.0000
-5	-1	-3	27	3	9	9	0.0000	0.0000	0.8201	0.0000
-10	-6	-8	10	0	4	3	0.0000	0.0000	0.2560	0.0000
-15	-11	-13	5	0	0	1	0.0000	0.0000	0.0975	0.0000
-20	-16	-17	3	0	0	1	0.0000	0.0000	0.0621	0.0000
-25	-21					0	0.0000	0.0000	0.0000	0.0000
-30	-26					0	0.0000	0.0000	0.0000	0.0000
-35	-31					0	0.0000	0.0000	0.0000	0.0000
-40	-36					0	0.0000	0.0000	0.0000	0.0000
-45	-41					0	0.0000	0.0000	0.0000	0.0000
Totals			2922	2914	2920	3125	3.6890	8.1363	82.4875	0.0000
Total operating hours for each system							446	948	2177	0

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 01/31/92

INPUTS:
1) Days Per Week That HVAC Operates — 5 Days/Week
2) Summer Room Dry Bulb Temperature — 75 °F (db)
   Room Wet Bulb Temperature — 63 °F (wb)
3) Winter Room Dry Bulb Temperature — 68 °F (db)
   If RH Controlled, wb Temp — °F (wb)
   and Ground Water Temperature — °F
4) Outside Air Quantity (cfm) — $\boxed{930\text{ cfm}}$
5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM — 2 Hrs/Shift
   8 AM -> 4 PM — 8 Hrs/Shift
   4 PM -> 12 M — 2 Hrs/Shift

Temperatures			Hours of Occurrence			Total	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24	Oper. Hours	Cooling	Dehumid	Heating	Humid.
120	124					0	0.0000	0.0000	0.0000	0.0000
115	119					0	0.0000	0.0000	0.0000	0.0000
110	114					0	0.0000	0.0000	0.0000	0.0000
105	109					0	0.0000	0.0000	0.0000	0.0000
100	104					0	0.0000	0.0000	0.0000	0.0000
95	99	75	0	7	0	5	0.1125	0.0921	0.0000	0.0000
90	94	72	0	28	6	21	0.3665	0.2583	0.0000	0.0000
85	89	71	0	95	28	73	0.8944	1.0080	0.0000	0.0000
80	84	68	4	177	73	140	1.0038	1.2099	0.0000	0.0000
75	79	66	27	248	140	207	0.4234	1.5008	0.0000	0.0000
70	74	64	115	257	222	244	0.0000	1.4977	0.0000	0.0000
65	69	61	234	235	271	258	0.0000	0.6101	0.0000	0.0000
60	64	57	263	212	252	243	0.0000	0.0000	1.4939	0.0000
55	59	52	274	190	236	227	0.0000	0.0000	2.5520	0.0000
50	54	48	263	183	214	216	0.0000	0.0000	3.5337	0.0000
45	49	43	242	183	205	211	0.0000	0.0000	4.5229	0.0000
40	44	38	229	202	205	222	0.0000	0.0000	5.8991	0.0000
35	39	34	261	241	251	264	0.0000	0.0000	8.3586	0.0000
30	34	30	295	220	262	257	0.0000	0.0000	9.4503	0.0000
25	29	25	216	156	191	184	0.0000	0.0000	7.7220	0.0000
20	24	20	163	112	130	132	0.0000	0.0000	6.2268	0.0000
15	19	16	110	79	96	93	0.0000	0.0000	4.8633	0.0000
10	14	11	84	43	65	57	0.0000	0.0000	3.2838	0.0000
5	9	6	60	27	38	37	0.0000	0.0000	2.2955	0.0000
0	4	2	37	16	22	22	0.0000	0.0000	1.4830	0.0000
-5	-1	-3	27	3	9	9	0.0000	0.0000	0.6226	0.0000
-10	-6	-8	10	0	4	3	0.0000	0.0000	0.1944	0.0000
-15	-11	-13	5	0	0	1	0.0000	0.0000	0.0740	0.0000
-20	-16	-17	3	0	0	1	0.0000	0.0000	0.0471	0.0000
-25	-21					0	0.0000	0.0000	0.0000	0.0000
-30	-26					0	0.0000	0.0000	0.0000	0.0000
-35	-31					0	0.0000	0.0000	0.0000	0.0000
-40	-36					0	0.0000	0.0000	0.0000	0.0000
-45	-41					0	0.0000	0.0000	0.0000	0.0000
Totals			2922	2914	2920	3125	2.8006	6.1769	62.6231	0.0000
Total operating hours for each system							446	948	2177	0

CONSTRUCTION COST ESTIMATE	DATE PREPARED 12-31-91	SHEET 7 OF

PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
WATERVLIET ARSENAL

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS

BASIS FOR ESTIMATE
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR W.T. Todd

CHECKED BY

Reduce Air Flow SUMMARY	QUANTITY		LABOR *		MATERIAL *		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Balance Air for multizone A/C and heating unit	1	Ea.	174	174	44	44	218
Balance air for 7 additional zones	7	Ea.	39	273	10	70	343
Subtotal				447		114	$ 561

Source: Means Mechanical Cost Data, 1991
Page 263, # 157 601 2500 & 2600

* Assuming Labor is 80% of total cost

* Costs are reduced by 15% for Overhead and by 10% for Profit to obtain "bare" costs

ENG FORM 150
1 AUG 59

(ER 1110-345-730))

PREVIOUS EDITION MAY BE USED

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—516146

(TRANSLUCENT)

02/05/92

ECO Construction Cost Estimate
Calculations

ECO Name: Reduce Air Flow, AHU 1, Building 120

ECO #: TBD

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$114
Labor		$447
	Subtotal bare costs	$561
FICA Insurance (20% of Labor)		$89
Sales Tax (Not Applicable For GOGO)		$0
	Subtotal	$650
Overhead (15%)		$98
	Subtotal	$748
Profit (10%)		$75
	Subtotal	$823
Bond (1%)		$8
	Subtotal	$831
Contingency (10%)		$83
Subtotal (Construction Cost Input For LCCID *)		$914
SIOH (6.0% of Construction Cost)		$55
	Subtotal	$969
Design (6.0% of Construction Cost)		$55
Total Project Cost		$1,024

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

RS&H®

SUBJECT	WVA - Building 115 Replace Old Cent. Chiller	AEP NO	290-0379-002
		SHEET	1 OF 6
DESIGNER	W. T. Todd	DATE	2-4-92
CHECKER		DATE	

ECO #14

Replace Old Electric Centrifugal Chiller

The centrifugal chillers in Building 115 are about 20 years old. The efficiencies of chillers at that time was approximately 1.0 to 1.2 KW/ton. Through the years technology has improved the efficiency of centrifugal chillers to about 0.7 KW/ton.

By replacing the old chiller with a new one, the efficiency would increase by (1.1 KW/ton - 0.7 KW/ton) = 0.4 KW/ton.

According to the Bin Temperature Data for Albany, NY, the outside air temperature is above 57 °F for 3594 hours per year. Assuming an operating diversity of 0.40, the chiller will operate:

$$3594 \text{ hr/yr} \times 0.40 = 1438 \text{ hr/yr}$$

Current Energy use (Electricity):

$$185 \text{ tons} \times 1.1 \frac{\text{KW}}{\text{Ton}} \times 1438 \frac{\text{hr}}{\text{Yr}} = 292,633 \text{ KWH/yr}$$

$$292,633 \frac{\text{KWH}}{\text{Yr}} \times 3413 \frac{\text{Btu}}{\text{KWH}} \times \frac{1 \text{ MBtu}}{10^6 \text{ Btu}} = \underline{998.8 \text{ MBtu/yr}}$$

RS&H

SUBJECT WVA - Building 115
Replace Old Cent. Chiller
DESIGNER W. T. Todd
CHECKER

AEP NO 290-0379-002
SHEET 2 OF
DATE 2-4-92
DATE

Future Energy Use (Electricity):

$$185 \text{ ton} \times 0.7 \frac{\text{KW}}{\text{ton}} \times 1438 \frac{\text{hr}}{\text{yr}} = 186,221 \text{ KWH/yr}$$

$$186,221 \frac{\text{KWH}}{\text{Yr}} \times 3413 \frac{\text{Btu}}{\text{KWH}} \times \frac{1 \text{ mBtu}}{10^6 \text{ Btu}} = \underline{635.6 \text{ mBtu/yr}}$$

Electricity Savings:

$$\text{Energy} = 998.8 \text{ mBtu/yr} - 635.6 \frac{\text{mBtu}}{\text{yr}} = \underline{363.2 \frac{\text{mBtu}}{\text{yr}}}$$

Project Implementation Cost:

Total Project Cost = $\underline{\$\ 149,176}$

See cost estimate sheets for details

CONSTRUCTION COST ESTIMATE

DATE PREPARED 2-4-92

SHEET 3 OF

PROJECT ENERGY ENGINEERING ANALYSIS

LOCATION WATERVLIET ARSENAL

ARCHITECT ENGINEER REYNOLDS, SMITH AND HILLS

BASIS FOR ESTIMATE
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.

ESTIMATOR W. T. Todd

CHECKED BY

Replace Chiller SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
200 ton Cent. Chiller	1	EA	20600	20600	64450	64450	85050
* Remove Exist. Chiller	1	EA	3000	3000	2000	2000	5000
Subtotal				$23,600		$66,450	$90,050

Source : Means Mechanical Cost Data, 1991

* 3 men @ $25 per hour for 5 days, plus equipment rental

ENG FORM 150 1 AUG 59 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—516148

02/05/92

ECO Construction Cost Estimate
Calculations

ECO Name: Replace Old Centrifugal Chiller

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$66,450
Labor	$23,600
Subtotal bare costs	$90,050
FICA Insurance (20% of Labor)	$4,720
Sales Tax (Not Applicable For GOGO)	$0
Subtotal	$94,770
Overhead (15%)	$14,216
Subtotal	$108,986
Profit (10%)	$10,899
Subtotal	$119,885
Bond (1%)	$1,199
Subtotal	$121,084
Contingency (10%)	$12,108
Subtotal (Construction Cost Input For LCCID *)	$133,192
SIOH (6.0% of Construction Cost)	$7,992
Subtotal	$141,184
Design (6.0% of Construction Cost)	$7,992
Total Project Cost	$149,176

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

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ALBANY NEW YORK

LAT 42 45N LONG 73 48W ELEV 275 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Temperature Range	MAY Obsn Hour Gp 01 to 08	MAY 09 to 16	MAY 17 to 24	MAY Total Obsn	MAY MCWB	JUNE Obsn Hour Gp 01 to 08	JUNE 09 to 16	JUNE 17 to 24	JUNE Total Obsn	JUNE MCWB	JULY Obsn Hour Gp 01 to 08	JULY 09 to 16	JULY 17 to 24	JULY Total Obsn	JULY MCWB
95/99							1	0	1	76		4	0	4	74
90/94		1	0	1	70		6	1	7	73		14	4	18	73
85/89		4	1	5	67	0	23	8	31	70		37	12	49	71
80/84		13	5	18	65	1	39	17	57	68	2	55	27	84	68
75/79	1	25	10	36	63	6	49	31	86	65	12	64	44	120	67
70/74	3	35	21	59	60	23	45	42	110	63	44	47	62	153	65
65/69	12	45	37	94	57	49	39	52	140	61	80	21	59	160	63
60/64	29	42	42	113	54	56	24	45	125	57	58	4	28	90	59
55/59	44	38	46	128	51	53	12	30	95	53	32	1	10	43	55
50/54	52	26	37	115	47	36	3	12	51	49	16		2	18	51
45/49	52	14	32	98	43	12		2	14	45	3			3	46
40/44	34	5	14	53	39	4		0	4	41	0			0	41
35/39	14	0	3	17	35	1			1	37					
30/34	7		0	7	31										
25/29	1			1	28										
20/24															

Temperature Range	AUGUST Obsn Hour Gp 01 to 08	AUGUST 09 to 16	AUGUST 17 to 24	AUGUST Total Obsn	AUGUST MCWB	SEPTEMBER Obsn Hour Gp 01 to 08	SEPTEMBER 09 to 16	SEPTEMBER 17 to 24	SEPTEMBER Total Obsn	SEPTEMBER MCWB	OCTOBER Obsn Hour Gp 01 to 08	OCTOBER 09 to 16	OCTOBER 17 to 24	OCTOBER Total Obsn	OCTOBER MCWB
95/99		1	0	1	75		1	0	1	76					
90/94		6	1	7	73		1	0	1	76					
85/89		21	5	26	71		9	2	11	73		0	0	0	62
80/84	1	48	18	67	69	0	18	5	23	71		2	0	2	67
75/79	6	64	38	108	66	2	30	14	46	67		11	1	12	64
70/74	29	60	57	146	65	15	40	28	83	64	1	18	7	26	62
65/69	62	32	63	157	63	24	48	34	106	60	4	28	13	45	58
60/64	65	12	42	119	59	37	47	47	131	57	11	44	27	82	55
55/59	47	3	18	68	55	46	28	46	120	53	30	47	43	120	52
50/54	27		6	33	51	45	13	34	92	49	38	43	48	129	47
45/49	11		0	11	47	38	4	20	62	45	50	33	47	130	44
40/44	1			1	43	19	0	7	26	41	43	14	34	91	39
35/39						10		2	12	36	36	7	17	60	35
30/34						4		0	4	32	24	1	10	35	31
25/29						0			0	28	9		1	10	27
20/24											2			2	22

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ALBANY NEW YORK

Temperature Range	NOVEMBER Obsn Hour Gp 01 to 08	NOVEMBER 09 to 16	NOVEMBER 17 to 24	NOVEMBER Total Obsn	NOVEMBER MCWB	DECEMBER Obsn Hour Gp 01 to 08	DECEMBER 09 to 16	DECEMBER 17 to 24	DECEMBER Total Obsn	DECEMBER MCWB	JANUARY Obsn Hour Gp 01 to 08	JANUARY 09 to 16	JANUARY 17 to 24	JANUARY Total Obsn	JANUARY MCWB
95/99															
90/94															
85/89															
80/84		0		0	64										
75/79		0		0	65										
70/74		0		0	64										
65/69	1	3	1	5	59										
60/64	2	11	4	17	56	0	0	0	0	57	0	0	0	0	56
55/59	7	18	13	38	52	2	3	2	7	54	1	1	0	2	54
50/54	17	34	23	74	48	3	5	5	13	48	1	2	1	4	49
45/49	26	42	32	100	43	5	11	7	23	43	2	3	3	8	45
40/44	38	46	43	127	38	10	20	12	42	38	8	15	8	31	39
35/39	40	43	45	128	34	27	43	33	103	34	21	33	29	83	34
30/34	45	28	43	116	30	45	51	50	146	30	34	43	38	115	30
25/29	35	11	25	71	25	41	39	46	126	25	33	43	39	115	25
20/24	20	2	8	30	21	35	32	32	99	20	31	37	38	106	20
15/19	6	1	3	10	17	28	22	23	73	16	32	30	35	97	16
10/14	2	0	1	3	12	21	10	19	50	11	29	19	25	73	11
5/9	1			1	8	15	6	9	30	7	22	13	16	51	6
0/4						8	4	5	17	2	18	7	10	35	2
-5/-1						5	1	2	8	-3	10	1	3	14	-3
-10/-6						2	0	1	3	-8	3	0	2	5	-8
-15/-11						1		0	1	-12	2	0	0	2	-13
-20/-16						1			1	-17	1			1	-17
-25/-21											0			0	-23

Temperature Range	FEBRUARY Obsn Hour Gp 01 to 08	FEBRUARY 09 to 16	FEBRUARY 17 to 24	FEBRUARY Total Obsn	FEBRUARY MCWB	MARCH Obsn Hour Gp 01 to 08	MARCH 09 to 16	MARCH 17 to 24	MARCH Total Obsn	MARCH MCWB
95/99										
90/94										
85/89										
80/84										
75/79							0	0	0	57
70/74							1	0	1	55
65/69							1	1	2	54
60/64		0		0	56		3	1	4	51
55/59		1		1	50	1	6	3	10	49
50/54	1	3	2	6	47	3	12	8	23	45
45/49	1	7	4	12	42	5	27	15	47	41
40/44	6	18	11	35	38	14	45	31	90	37
35/39	21	42	32	95	34	36	55	54	145	33
30/34	36	46	46	128	30	67	46	59	172	30
25/29	35	36	39	110	25	47	27	38	112	25
20/24	34	26	30	90	20	37	14	22	73	20
15/19	24	19	24	67	15	18	7	10	35	15
10/14	21	12	16	49	11	11	2	4	17	11
5/9	17	7	11	35	6	5	1	2	8	6
0/4	8	5	6	19	1	3	0	1	4	2
-5/-1	11	1	4	16	-3	1	0	0	1	-4
-10/-6	5	0	1	6	-8	0		0	0	-8
-15/-11	2	0		2	-13	0			0	-14
-20/-16	1			1	-17	0			0	-17
-25/-21										

Temperature Range	APRIL Obsn Hour Gp 01 to 08	APRIL 09 to 16	APRIL 17 to 24	APRIL Total Obsn	APRIL MCWB	ANNUAL TOTAL Obsn Hour Gp 01 to 08	ANNUAL TOTAL 09 to 16	ANNUAL TOTAL 17 to 24	ANNUAL TOTAL Total Obsn	ANNUAL TOTAL MCWB
95/99							7	0	7	75
90/94		0		0	63		28	6	34	73
85/89		1	0	1	65	0	95	28	123	71
80/84		2	1	3	63	4	177	73	254	68
75/79		5	2	7	60	27	248	140	415	66
70/74	0	11	5	16	57	115	257	222	594	64
65/69	2	18	11	31	55	234	235	271	740	61
60/64	5	25	16	46	51	263	212	252	727	57
55/59	11	32	25	68	49	274	190	236	700	52
50/54	24	42	36	102	45	263	183	214	660	48
45/49	37	42	43	122	42	242	183	205	630	43
40/44	52	39	45	136	38	229	202	205	636	38
35/39	55	18	36	109	34	261	241	251	753	34
30/34	33	5	16	54	30	295	220	262	777	30
25/29	15	0	3	18	25	216	156	191	563	25
20/24	4	1	0	5	20	163	112	130	405	20
15/19	2	0	1	3	16	110	79	96	285	16
10/14						84	43	65	192	11
5/9						60	27	38	125	6
0/4						37	16	22	75	2
-5/-1						27	3	9	39	-3
-10/-6						10	0	4	14	-8
-15/-11						5	0	0	5	-13
-20/-16						3			3	-17
-25/-21						0			0	-23

14-6

SUBJECT	ECO# 15 EMCS	AEP NO	290-0379-002
		SHEET	OF
DESIGNER		DATE	3/25/92
CHECKER		DATE	

RS&H®

ECO #15 - EMCS

DUE TO THE LARGE SIZE OF THE BACKUP DATA FOR THE EMCS, A TABLE OF CONTENTS IS SHOWN HERE

TABLE OF CONTENTS - ECO#15 - EMCS

RS&H®

SUBJECT WVA - 26 Buildings Install EMCS | AEP NO 290-0379-002
SHEET ____ OF ____
DESIGNER Todd / Hutchins | DATE 3-18-92
CHECKER ____ | DATE ____

ECO # 15

Install Energy Monitoring and Control Systems

The EMCS can be used control various functions of a buildings energy using equipment. Of the many software programs available, only Day/Night Setback and Ventilation & Recirculation were judged to be technically and economically feasible. A block diagram of the system is shown on p

Current Energy Use

Virtually all of the steam generated by the boilers in Building 136 is used for space heating applications. These boilers burn approximately 280,000 mBtu/year of fuel oil #6 to heat about 2.15 million square feet of building floor area. The 26 buildings that are included in this analysis have about 1.65 million square feet of floor area (see next Page)

Using the square footage values to estimate the heating energy required for the 26 buildings that will utilize the EMCS:

$$\text{Total Heating Energy Use} = 280{,}000 \ \text{mBtu/yr}$$

$$\text{Current Energy Use} = 280{,}000 \frac{\text{mBtu}}{\text{yr}} \times \frac{1.65 \times 10^6 \ ft^2}{2.15 \times 10^6 \ ft^2}$$

$$\text{Current Energy Use} = \underline{214{,}900 \frac{\text{mBtu}}{\text{yr}}} \quad (\text{F.O. } \#6)$$

ECO#15 - EMCS

Watervliet Arsenal EMCS
Square Footage Calculation
Filename: SQFTHEAT.WQ1

03/20/92

Building Number	Floor Area (SqFt)	Heated Area (SqFt)
1	13666	
2	9828	
3	9740	
4	14000	
6	15970	
8	11173	
9	4338	
10	67790	67790
11	131	
12	1320	
15	22990	22990
16	219	
17	7714	7714
18	1764	
19	9208	
20	107157	107157
21	17121	17121
22	9955	
23	21527	21527
24	11876	11876
25	185886	185886
29	210	
35	372921	186461
36	6293	
38	29400	6100
40	192221	192221
41	5023	
42	218	
43	300	
44	61278	61278
46	405	
47	405	
48	1074	
49	221	
50	1213	
102	240	
Subtotal	1214795	888121

Building Number	Floor Area (SqFt)	Heated Area (SqFt)
107	289	
108	2988	
110	208574	208574
111	146	
112	2633	
113	108	
114	4597	4597
115	49926	49926
116	6082	6082
118	1536	
119	3765	
120	101975	101975
121	6445	6445
122	1552	
123	8262	8262
124	13199	13199
125	119200	119200
126	6614	6614
128	269	
129	3765	
130	30904	30904
132	2342	2342
133	7200	
134	324	
135	191964	191964
136	28608	
137	315	
138	600	
139	600	
140	600	
141	1708	
144	65	
145	126720	7600
146	655	
150	1840	
Subtotal	936370	757684
Subtotal	1214795	888121
Totals	2151165	1645805

RS&H®

SUBJECT ECO# 15 EMCS

AEP NO 290-0379-002

SHEET ____ OF ____

DESIGNER P. HUTCHINS

DATE

CHECKER

DATE

EMCS FUNCTIONS SUMMARY

1. Scheduled Start/Stop	ALREADY EXISTS
2. DUTY CYCLING	LPS, IOM
3. DEMAND LIMITING	INCLUDED
4. OPTIMUM START/STOP	EVALUATED, LOW SAVINGS
5. OUTSIDE AIR LIMIT SHUTOFF	~~I~~ LPS
6. VENTILATION & RECIRC.	INCLUDED
7. ECONOMIZER	ALREADY EXISTS
8. DAY/NIGHT SETBACK	INCLUDED
9. REHEAT COIL RESET	NA
10. HOT DECK/COLD DECK TEMP. RESET	LPS
11. HW OSA RESET	LPS
12. BOILER OPTIMIZATION	NA - one boiler normally used
13. CHILLER OPTIMIZATION	NA
14. CHILLER WATER TEMP. RESET	EVALUATED, NOT RECOMMENDED
15. CONDENSER WATER TEMP. RESET	EVALUATED, NOT RECOMMENDED
16. CHILLER DEMAND LIMIT	NA, ONLY ONE CENTRIFUGAL CHILLER (1)
17. LIGHTING CONTROL	NO APPROPRIATE AREAS IDENTIFIED

NOTES: LPS - LOW POTENTIAL SAVINGS
IM - INCREASED MAINTENANCE
NA - not applicable
(1) - Not recommended for recip's

3/92

SUBJECT ECO #15 EMCS

AEP NO

SHEET OF

DESIGNER

DATE

CHECKER

DATE

RS&H®

ENERGY SAVINGS SUMMARY SHEET

EMCS FUNCTION	SAVINGS
DEMAND LIMITING	\$5124/yr demand reduction
DAY/NIGHT SETBACK	9164 MBTU/yr (#6 Fuel Oil)
VENTILATION & RECIRCULATION	687 MBTU/yr (#6 Fuel Oil)
MAINTENANCE	\$1100/yr

TOTALS

#6 Fuel oil	9851 MBTU/yr.
Other Dollars	\$6224/yr

15-3a

8/92

RS&H®	SUBJECT ECO #15 - EMCS	AEP NO 290-0379-002	
		SHEET	OF
	DESIGNER Hutkins	DATE 3/21/92	
	CHECKER	DATE	

EMCS - Demand Limiting

- Evaluate savings due to Demand Limiting

The following chillers can be de-energized for short periods of time to reduce peak demand. They serve administrative areas.

Bldg #	SIZE (tons)		OPERATION
10	44		year round
20	30		"
25 (1)	60	284	"
25 (2)	60		"
40	90		"
44	90		summer only
115	185	425	"
120	150		"
TOTAL	709		

KW SAVINGS = HP * L * (0.746 kw/hp) + 0.25

Assume approximately 1 Kw/ton for chillers and auxiliaries

HP = motor nameplate horsepower
L = load factor = 0.8 (p. 35, CR 82-030)
ratio of motor partial loading and efficiency
varies from 0.25 in winter
to 0.50 in fall/spring
to 0.80 in summer

RS&H®

SUBJECT ECO#15

DESIGNER JH

CHECKER

AEP NO

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Year round capacity = 284 tons = 234 kw

Summer only cap. = 425 tons

kW savings = 425 * 0.25 * 0.25 = 27 kw
425 * 0.50 * 0.25 = 53 kw
709 * 0.80 * 0.25 = 142 kw

Annual dollar savings =

27 kw * 5.77 $/kw/mon * 4 mos +
53 kw * 5.77 $/kw/mon * 4 mos +
142 kw * 5.77 $/kw/mon * 4 mos =

$5124 /yr.

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WATERVLIET ARSENAL

BLDG #	CHILLER TYPE	CHILLER SIZE (TONS)	HVAC SYSTEM TYPE AHU	HVAC SYSTEM TYPE PERIM	SUP FAN (HP)	EXH FAN (HP)
10 (adm)	RC/DX/AC	44	VAV	HW/PR	15	-
(cmp)	RC/DX/AC	25	SZ	-	7.5	-
(rep)	RC/DX/AC	5	SZ	HW/PR	1	-
(cmp)	RC/DX/AC	5	SZ	-	1	-
15 (adm)	RC/DX/AC	8	SZ	ST/PR+UH	1	-
20 (adm)	RC/DX/AC	30	VVT	ST/PR	7.5	-
21 (caf)	-	-	SZ	ST/PR	-	-
23 (adm)	-	-	-	ST/PR	-	0.5
24 (adm)	RC/DX/AC	5,5	SZ	ST/PR	0.75	-
25 (adm)	RC/DX/AC	60,60	VAV	HW/PR	30,30	10,10
(cmp)	RC/DX/AC	10,10	SZ	-	2	-
35 (cls)	RC/DX/AC	25	VAV	ST/PR	2	-
40 (mf)	RC/DX/AC	25	SZ	HW/PR	7.5	-
(cd)	RC/DX/AC	30	SZ	HW/PR	7.5	-
(adm)	RC/CW/AC		FC	HW/PR	-	-
(dft)	RC/DX/AC	5	SZ	HW/PR	1	-
(ncf)	RC/DX/AC	11	SZ	HW/PR	2	-
(scf)	RC/DX/AC	10	SZ	HW/PR	2	-
44 (adm)	RC/CW/AC	90	SZ	ST/PR	25,5	-
(lab)	RC/CW/AC	75	SZ	-	20	-
(cmp)	RC/DX/AC	90	SZ	-		-
(bsm)	-	-	SZ	ST/UH	30	-
115 (adm)	CC/CW/WC	185,185(bu)	RH	FC	7.5,5,2,FC	-
(cmp)	RC/DX/AC	28	SZ	-	7.5	-
120 (adm)	RC/CW/AC	150	MZ	PR+FC	7.5	-
(cwl)	RC/CW/AC	150	SZ	PR+FC	7.5,FC	-
(el)	RC/CW/AC	40	-	PR+FC	FC	-

CHILLER TYPES
RC = reciprocating chiller
CC = centrifugal chiller
DX = direct expansion
CW = chilled water
AC = air cooled
WC = water cooled

HVAC TYPES
VAV = variable air volume
VVT = variable volume, temperature contol
SZ = single zone
MZ = multi zone
RH = terminal reheat

AREAS
mf = microfilm
adm = administrative areas
lab = laboratory areas
bsm = basement areas
cd = CADD
dft = drafting room
ncf = north conference room
scf = south conference room
cmp = computer room
cwl = central and west labs
el = east labs
rep = reproduction

PERIMETER SYSTEMS
PR = perimeter radiation
UH = unit heater
FC = fan coils

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CONSTRUCTION COST ESTIMATE

DATE PREPARED 8/21/92

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PROJECT
ENERGY ENGINEERING ANALYSIS

LOCATION
WATERVLIET ARSENAL

ARCHITECT ENGINEER
REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [ ] CODE A (No design completed)
- [x] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. ECO#15 - EMCS

ESTIMATOR P. HUTCHINS

CHECKED BY

DEMAND LIMITING SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
CONTROL RELAY	8	ea	25	200	87	696	896
AUXILIARY CONTACT	8	ea	25	200	15	120	320
WATT TRANSDUCER SET							
3- PHASE	1	ea	23	23	425	425	448
120 Volt AC Power	8	ea	75	600	39	312	912
Wiring - indoor	400'	1000'	450	180	510	204	384
Computer program	1	ea					2370
							$ 5330

ENG FORM 150
1 AUG 59

(ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—516148

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Day/Night Setback

Calculate savings due to Day/Night Setback

Ref: User Guide for Single Bldg Controllers (CR 82.030 p. 51)

$$\text{Heat Savings} = \frac{BTT * AZ * SD * (168-H) * WKW}{HEFF \div 1e6}$$

where

AZ = area of zone being served (ft^2)
BTT = building thermal transmission ($BTU/hr\ {}^\circ F - ft^2$)
SD = thermostat setdown for unoccupied periods during heating season = 10°F
H = hours of operation during week during which the normal setpoint applies
WKW = length of winter heating season
HEFF = heating efficiency of system = 0.80

The heating energy savings due to day/night setback were calculated using a spreadsheet computer program and the equation shown above.

The spreadsheet and all assumptions are given on the next 3 pages. The results are:

Setback Energy Savings = 9,164 $\frac{MBtu}{Yr}$ (F.O. #6)

ECO #15 - EMCS

WATERVLIET ARSENAL EMCS
SETBACK CALCULATION
Filename: SETBK.WQ1
03/20/92

#	BLDG #	WALL AREA (SF)	WINDOW AREA (%)	WINDOW TYPE	ROOF AREA (SF)	Uo*Aw	Uo	HEATED FL AREA (SF)	VOLUME (CF)	INFIL. (CFM)	S/B ?	BTT	H (HR/WK)	HEATING SAVINGS (MBTU)
1	10	17,850	20	2	21,750	9,310	0.24	67,790	610,110	2,542	1	0.18	50	481
2	15	6,350	10	1	23,000	3,676	0.13	22,990	206,910	862	1	0.20	50	184
3	17	3,952	15	1	7,714	1,788	0.15	7,714	69,426	289	1	0.27	50	84
4	20(adm)	3,200	10	2	9,600	1,869	0.15	9,600	86,400	360	1	0.24	120	37
	20(shops)	7,200	15	1	48,779	6,209	0.11	97,557	878,013	3,658	1	0.59	120	940
5	21	5,120	30	2	17,100	4,049	0.18	17,121	154,089	642	1	0.28	120	77
6	22	4,490	15	2	9,955	2,523	0.17	9,955	89,595	373	0	0.00	168	0
7	23	9,240	25	1	4,940	3,354	0.24	21,527	193,743	807	1	0.20	50	169
8	24	5,170	30	1	3,670	2,034	0.23	11,876	106,884	445	1	0.21	50	100
9	25(adm)	12,070	10	2	66,100	9,590	0.12	66,100	594,900	2,479	1	0.19	50	490
10	25(shops)	24,140	15	1	0	6,916	0.29	119,786	1,078,074	4,492	1	0.10	120	191
11	35	43,968	15	1	372,921	44,295	0.11	186,461	1,678,145	6,992	1	0.28	120	842
12	38	6,440	25	1	6,100	2,563	0.20	6,100	54,900	229	1	0.46	50	112
13	40	51,700	25	2	88,900	31,468	0.22	192,221	1,729,989	7,208	1	0.20	50	1,567
14	44	8,040	15	2	61,300	8,213	0.12	61,278	551,502	2,298	1	0.17	50	427
15	110	71,488	25	1	208,574	40,426	0.14	208,574	1,877,166	7,822	1	0.23	120	793
16	114	2,589	15	2	4,597	1,358	0.19	4,597	41,373	172	1	0.34	50	62
17	115	16,960	10	2	32,840	8,371	0.17	49,926	449,334	1,872	1	0.21	50	415
18	116	2,978	15	1	6,082	1,370	0.15	6,082	54,738	228	1	0.27	50	65
19	120	24,240	10	1	30,800	9,187	0.17	101,975	917,775	3,824	1	0.13	50	532
20	121	3,065	15	1	6,445	1,426	0.15	6,445	58,005	242	1	0.26	50	67
21	123	3,471	15	1	8,262	1,697	0.14	8,262	74,358	310	1	0.25	50	81
22	124	4,387	15	1	13,199	2,379	0.14	13,199	118,791	495	1	0.22	50	116
23	125	13,183	15	1	119,200	13,909	0.11	119,200	1,072,800	4,470	1	0.16	120	304
24	126	3,105	15	1	6,614	1,452	0.15	6,614	59,526	248	1	0.26	50	69
25	130	13,600	25	1	30,900	6,945	0.16	30,904	278,136	1,159	1	0.27	50	327
26	132	1,742	10	1	2342	671	0.16	2,342	21,078	88	1	0.33	50	31
27	135	16,730	20	1	191,964	21,369	0.10	191,964	1,727,676	7,199	1	0.15	120	473
28	145	9,600	0	1	7,600	2,950	0.17	7,600	68,400	285	1	0.43	50	130
	Totals					251,366		1,655,760	14,901,836	62,091	28			9,164

ASSUMPTIONS:

Wall U-value : 0.24 Btu/sf-F-hr
Window U-value (1-pane) 1.13 Btu/sf-F-hr
Window U-value (2-pane) 0.55 Btu/sf-F-hr
Roof U-value : 0.085 Btu/sf-F-hr
Average infiltration : 0.25 volumes/hour

$$\text{Heating savings} = \frac{BTT * AZ * SD * (168-H) * WKW}{HEFF / 1e6}$$

where:

BTT = [(Uo * Aw) + (I * 1.08 Btu/cfm-F-hr)]/AF
Uo = overall wall U-value
Aw = wall area (sf)
I = infiltration (cfm)
AF, AZ = floor area (sf)
SD = thermostat set-down during heating season (10'F)
H = hours per week building is occupied
WKW = weeks of winter (see calcs on next page)
HEFF = 0.80

ECO #15 - EMCS

WATERVLIET ARSENAL EMCS
WEEKS OF WINTER CALCULATION
Filename: SETBK.WQ1

Outside Temperature Range		Hours of Occurrence 2-9	10-17	18-1	Total Hours
50	54	221	193	202	616
45	49	218	193	206	617
40	44	237	236	239	712
35	39	289	246	286	821
30	34	304	194	258	756
25	29	184	106	152	442
20	24	124	65	90	279
15	19	75	32	57	164
10	14	54	13	26	93
5	9	18	3	9	30
0	4	9	0	2	11
-5	-1	3	0	1	4
-10	-6	1	0	0	1
-15	-11	0	0	0	0
Totals		1737	1281	1528	4546

Total weeks of winter (WKW) = 4546 / 24 / 7 = 27

Data source : TM 5-785

Assumptions for Day/Night Setback Calculation:

$$BTI = [(U_o * A_w) + (I * 1.08 \text{ Btu/cfm}^\circ\text{F-hr})]/AF$$

U_o = combined U-factor for all exterior surfaces (Btu/ft²·hr·°F)
A_w = total area of exterior surfaces (ft²)
I = total infiltration for building (cfm)
AF = total floor area of building (ft²)

From ASHRAE Handbook, 1977 Fundamentals, Chapter 25.

Wall U-value for 4 in face brick, 8 in common brick with air space is 0.24

$U_w = 0.24$

Roof U-value for Roof made of 4 in wood and 1" insulation is 0.085

$U_R = 0.085$

U-value for single-pane windows is 1.13, double or storm is 0.55

$U_{w1} = 1.13 \quad U_{w2} = 0.55$

Infiltration is very difficult to calculate but it is known to range from about 0.3 to 1.0 air changes per hour for residential buildings (ASHRAE 1981 Fundamentals, p.22-8). Commercial buildings tend to be tighter than residential, so a value of 0.25 air changes per hour is assumed.

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Ventilation & Recirculation

The heating energy savings for this program were calculated using a spreadsheet computer program and the following equation:

$$\text{Savings} = \frac{\text{CFM} \times \text{POA} \times (\text{WSP}-\text{AWT}) \times 1.08 \times \text{AND} \times (\text{WH}-0.25)}{\text{HEFF} \times 1e6 \left(\frac{\text{Btu}}{\text{mBtu}}\right)}$$

The assumptions and results of the calculations are shown on the following 2 pages.

The air handling unit cfm was obtained from shop drawings or estimated using the following equation:

$$\text{CFM} = \frac{\text{Motor HP} \times 6356 \times \text{Efficiency}}{\text{Static Pressure (in. } H_2O)}$$

The results of the savings calculations are:

V&R Energy Savings = 687 MBtu/yr (F.O. #6)

Total Energy Savings

Total Energy Savings = Setback Savings + V&R Savings

Total Energy Savings = 9,164 $\frac{\text{mBtu}}{\text{Yr}}$ + 687 $\frac{\text{mBtu}}{\text{Yr}}$ = 9,851 MBtu/yr

ECO #15 - EMCS

WATERVLIET ARSENAL EMCS 03/20/92
VENTILATION & RECIRCULATION SAVINGS CALCULATION
Filename: V&REC.WQ1

#	BLDG #	(Area)	AHU Fan HP	AHU Fan #	VENT. CFM (1)	WARM-UP VENT. SAVINGS (MBTU)
1	10	(adm)	15.0	1	18,000	53
2		(cmp)				
3		(rep)				
4		(cmp)				
5	15	(adm)				
6	20	(adm)	7.5	1	12,000	35
7	21	(caf)				
8	23	(adm)				
9	24	(adm)				
10	25	(adm)	60.0	2	96,000	281
11		(cmp)				
12	35	(cls)				
13	40	(mf)	7.5	1	12,000	35
14		(cd)	7.5	1	12,000	35
15		(adm)	15.0	2	24,000	70
16		(dft)				
17		(ncf)				
18		(scf)				
19	44	(adm)	25.0	1	20,000	59
20		(lab)				
21		(cmp)				
22		(bsm)	30.0	1	34,400	101
23	115	(adm)				
24		(cmp)				
25	120	(adm)	7.5	1	6,250	18
26		(cwl)				
27		(el)				
	Totals		175.0	11	234,650	687

(1) Ventilation CFM estimated based on motor horsepower

$$\text{SAVINGS} = \frac{\text{CFM*POA*(WSP-AWT)*(1.08 BTU/CFM-F-HR)*AND*(WH-0.25)}}{\text{HEFF*1E6(BTU/MBTU)}}$$

Where:

CFM = Varies = air handler capacity, in Cubic Feet per Minute
POA = 0.25 = minimum outside air (% of CFM)
WSP = 70 = winter thermostat setpoint (°F)
AWT = 42 = average winter OA temp. (°F, see App. B, p. I-8)
AND = 248 = annual days requiring warm-up (see next page)
WH = 1.5 = present warm-up hours (Hours/Day)
HEFF = 0.8 = boiler efficiency

ECO #15 - EMCS

WATERVLIET ARSENAL EMCS
ANNUAL DAYS REQUIRING WARM-UP CALCULATION
Filename: V&REC.WQ1

Outside Temperature Range		Hours of Occurrence 1-8	9-16	17-24	Total Hours
50	54	221	193	202	616
45	49	218	193	206	617
40	44	237	236	239	712
35	39	289	246	286	821
30	34	304	194	258	756
25	29	184	106	152	442
20	24	124	65	90	279
15	19	75	32	57	164
10	14	54	13	26	93
5	9	18	3	9	30
0	4	9	0	2	11
-5	-1	3	0	1	4
-10	-6	1	0	0	1
-15	-11	0	0	0	0
Totals		1737	1281	1528	4546

Total days requiring warm-up = 1737 / 7 = 248

Data source : TM 5-785

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Optimum Start / Stop Evaluation

- Calculate energy savings

Currently air handlers in administrative areas ~~are~~ operate from 0600-1800 and are energized and de-energized by a time clock controller. The Optimum Start/Stop function would reduce the present warm-up time from 1.5 hours to a shorter time period based on the thermal characteristics of the building and its location geographically.

The calculations were made based on CR 82.030 methods and are shown in the table on the following page. Savings are too small ~~$~~ (~$200/yr) warrant implementing this function.

WATERVLIET ARSENAL
OPTIMUM START/STOP SAVINGS CALCULATION

#	BLDG #	WARM-UP AUXILIARIES (HP)	COOL-DOWN AUXILIARIES (HP)	Uo	ERT	WARM-UP SAVINGS (MBTU)	COOL-DOWN SAVINGS (MBTU)	TOTAL SAVINGS (MBTU)
1	10	15	15	0.24	370	0	2	2
2	15			0.13	250			
3	17			0.15	290			
4	20(adm)	7.5	7.5	0.15	275	1	1	2
5	20(shops)			0.11	230			
6	21			0.18	320			
7	22			0.17	310			
8	23			0.24	370			
9	24			0.23	370			
10	25(adm)	60	60	0.12	250	11	8	18
11	25(shops)			0.29	390			
12	35			0.11	215			
13	38			0.20	340			
14	40	7.5	7.5	0.22	350	0	1	1
15	44	60	60	0.12	230	12	8	20
16	110			0.14	275			
17	114			0.19	320			
18	115	14.5	14.5	0.17	300	2	2	3
19	116			0.15	290			
20	120	15	15	0.17	300	2	2	3
21	121			0.15	275			
22	123			0.14	275			
23	124			0.14	260			
24	125			0.11	215			
25	126			0.15	275			
26	130			0.16	290			
27	132			0.16	300			
28	135			0.10	215			
						27	23	50

WARM-UP SAVINGS =

HP X L X (0.746 KW/HP) X ((WH X AND) - ERT) X (DAY/7 DY/WK)
X 0.003413 (MBTU/KWH)

where

- HP = motor horsepower
- L = motor efficiency load factor (0.8)
- WH = present warm-up time (estimate 1.5 hrs)
- AND = annual number of days total that warmup is required (248 da/yr)
- ERT = equipment run time total required for warm-up (hrs/yr)
- DAY = equipment operation (dy/wk)

COOL-DOWN SAVINGS =

HP X L X (0.746 KW/HP) X ((CH - 0.75 HR/DA) X (365 DY/YR - AND)
X (DAY /7 DY/WK) X 0.003413 (MBTU/KWH)

where

- CH = present cool-down time (estimate 1.5 hrs)

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CHILLED WATER RESET FUNCTION

- Calculate energy savings (ref. CR 82.030 p. 58)

SAV = TON * CPT * CFLH * 2°F * REI

where

TON = chiller capacity
CPT = energy use per ton (kw/ton)
CFLH = equivalent full-load hours for cooling (hrs/yr)
REI = efficiency increase per °F increase in chilled water temp.
= 0.012 /°F for reciprocal
= 0.017 /°F for centrifugal

Mean °F	09 to 16 Hours of Occurrence	Degree Hours c (H-65)
97	7	224
92	28	756
87	95	2090
82	177	3009
77	248	2976
72	257	1799
67	235	470
		11,324 °F-hr

CFLH = 11,324 ÷ (Cooling design temp. - 65°F)

= 11324 ÷ (88-65) = 492 hr/yr.

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Chiller efficiencies: (Ref.: DOE-2)

	COP	CPT (kw/ton)
centrifugal	4.8	0.73
reciprocal	3.6	0.98

$$\frac{kW}{ton} = \frac{kW_{in}}{3413\,Btuh_{in}} * \frac{Btuh_{in}}{Btuh_{out}} * \frac{12{,}000\ Btuh_{out}}{ton}$$

$\frac{1}{COP}$

$$\frac{kW}{ton} = \frac{12{,}000}{3413 * COP}$$

SAVINGS = TON * CPT * CFLH * 2 * REI

RECIP = TON * 0.98 * 492 * 2 * 0.012

RECIP = 11.57 * TON (kwh)

CENTRIF = TON * 0.73 * 492 * 2 * 0.017

CENTRIF = 12.21 * TON (kwh)

SAVINGS CALCULATION

LOCATION	SIZE (TONS)	TYPE(1)	SAVINGS PER YEAR KW	MBTM	$
44 ADM	90	R	1041	3.6	$72
115 ADM	185	C	2257	7.7	$157
120 ADM	150	R	1736	5.9	$120
120 LAB(W)	150	R	1736	5.9	$120
120 LAB(E)	40	R	463	1.6	$33
40 ADM	100	R	1157	4.0	$80

$580/yr

WATERVLIET ARSENAL
OPTIMUM START/STOP CALCULATION

BLDG #	CHILLER TYPE	CHILLER SIZE (TONS)	HVAC SYSTEM TYPE AHU	HVAC SYSTEM TYPE PERIM	SUP FAN (HP)	EXH FAN (HP)	OPERATING SCHEDULE ON	OPERATING SCHEDULE OFF	OPERATING SCHEDULE DA/WK	ST	DP	CR	WT	TOT
10 (adm)	RC/DX/AC	44	VAV	HW/PR	15	-	0600	1800	5	1	1	1	1	4
(cmp)	RC/DX/AC	25	SZ	-	7.5	-	0000	2400	7	0				0
(rep)	RC/DX/AC	5	SZ	HW/PR	1	-	0600	1800	5	1	1	1	0	3
(cmp)	RC/DX/AC	5	SZ	-	1	-	0000	2400	7	0				0
15 (adm)	RC/DX/AC	8	SZ	ST/PR+UH	1	-	0600	1800	5	1	1	1		3
20 (adm)	RC/DX/AC	30	VVT	ST/PR	7.5	-	0600	1800	5	1	1	1		3
21 (caf)	-	-	SZ	ST/PR	-	-	0600	1800	5	0				0
23 (adm)	-	-	-	ST/PR	-	0.5	0600	1800	5	0				0
24 (adm)	RC/DX/AC	5,5	SZ	ST/PR	0.75	-	0600	1800	5	0				0
25 (adm)	RC/DX/AC	60,60	VAV	HW/PR	30,30	10,10	0600	1800	5	2	2	2		6
(cmp)	RC/DX/AC	10,10	SZ	-	2	-	0000	2400	7	0				0
35 (cls)	RC/DX/AC	25	VAV	ST/PR	2	-	as needed			0				0
40 (mf)	RC/DX/AC	25	SZ	HW/PR	7.5	-	0600	1800	5	1	1	1		3
(cd)	RC/DX/AC	30	SZ	HW/PR	7.5	-	0600	1800	5	1	1	1		3
(adm)	RC/CW/AC		FC	HW/PR	-	-	0600	1800	5	1	1	1		3
(dft)	RC/DX/AC	5	SZ	HW/PR	1	-	0600	1800	5	1	1	1		3
(ncf)	RC/DX/AC	11	SZ	HW/PR	2	-	as needed			0				0
(scf)	RC/DX/AC	10	SZ	HW/PR	2	-	as needed			0				0
44 (adm)	RC/CW/AC	90	SZ	ST/PR	25,5	-	0600	1800	5	1	1	1		3
(lab)	RC/CW/AC	75	SZ	-	20	-	0000	2400	7	0				0
(cmp)	RC/DX/AC		SZ	-		-	0000	2400	7	0				0
(bsm)	-	-	SZ	ST/UH	30	-	0000	2400	7	1	1	1		3
115 (adm)	CC/CW/WC	185,185(bu)	RH	FC	7.5,5,2,FC	-	0600	1800	5	3	3	3		9
(cmp)	RC/DX/AC	28	SZ	-	7.5	-	0000	2400	7	0				0
120 (adm)	RC/CW/AC	150	MZ	PR+FC	7.5	-	0600	1800	5	1	1	1		3
(cwl)	RC/CW/AC	150	SZ	PR+FC	7.5,FC	-	0600	1800	5	1	1	1		3
(el)	RC/CW/AC	40	-	PR+FC	FC	-	0600	1800	5	1	1	1		3

CHILLER TYPES
RC = reciprocating chiller
CC = centrifugal chiller
DX = direct expansion
CW = chilled water
AC = air cooled
WC = water cooled

HVAC TYPES
VAV = variable air volume
VVT = variable volume, temperature contol
SZ = single zone
MZ = multi zone
RH = terminal reheat

AREAS
mf = microfilm
adm = administrative areas
lab = laboratory areas
bsm = basement areas
cd = CADD
dft = drafting room
ncf = north conference room
scf = south conference room
cmp = computer room
cwl = central and west labs
el = east labs
rep = reproduction

PERIMETER SYSTEMS
PR = perimeter radiation
UH = unit heater
FC = fan coils

RS&H®

SUBJECT ______________________ AEP NO ______________

______________________ SHEET ______ OF ______

DESIGNER ______________________ DATE ______________

CHECKER ______________________ DATE ______________

ESTIMATE PAYBACK - CHILLED WATER RESET

COST ESTIMATE

		UNIT COST [1]	
• CHILLED WATER TEMP. SENSOR	(6)	$143	858
• CHILLED WATER TEMP. CONTROL POINT ADJ.	(6)	200	1200
• OSA	–		
• WIRING (~$450/pt) 2pts/CHILLER	(6)	900	5400
• Computer program	(1)	1500	1500
			$8958
Mark-ups (~58%)			5196
			$14,154

$$\text{Payback} = \frac{14{,}154}{580} = \underline{\underline{24}}\ \text{yrs.}$$

Not Recommended.

[1] See detailed cost estimate sheets in this section

RS&H®

SUBJECT ECO #15 EMCS

DESIGNER

CHECKER

AEP NO

SHEET ____ OF ____

DATE

DATE

CONDENSER WATER RESET

- CALCULATE ENERGY SAVINGS (Ref. CR 82.030)

COOLING SAVINGS = TON * CPT * CFLH * AEI

where TON = chiller capacity (tons)
CPT = efficiency (kW/ton)
CFLH = equivalent full-load cooling hrs (hrs/yr)
AEI = adjusted eff. increase due to cond. reset

$$AEI = \frac{PEI + 5.5}{100}$$ from Fig. 12 p. 61 and RCWT

RCWT = PCWT - ACWT

where ACWT = achievable condenser water temp.
PCWT = present " " " (85°F)
RCWT = reduction in " " "
PEI = percent eff. increase

PEI = 6% from Fig 12, p61 for RCWT = 12.6°F and centrifugal chiller

$$AEI = \frac{6 - 5.5}{100} = 0.01$$

SAVINGS = 185 tons * 0.73 kW/ton * 492 hrs/yr * 0.01

= 664 kwh/yr = 2.27 MBTU/yr => $46/yr

RS&H®

SUBJECT ECO #15 - EMCS

AEP NO

SHEET OF

DESIGNER

DATE

CHECKER

DATE

ACWT CALCULATION

A MEAN COINCIDENT WET BULB (°F)	B COND. WATER TEMP (A + 10°)	C 09 TO 16 HOURS OF OCCURRENCE	D TEMP. HRS (BxC)
75	85	7	595
73	83	28	2324
71	81	95	7695
68	78	177	13,806
66	76	248	18,848
64	74	257	19,018
61	71	235	16,685
57	67	212	14,204
52	62	190	11,780
		1449	104,955

ACWT = TOTAL of D ÷ TOTAL OF C

104,955 ÷ 1449 = 72.4 °F

RCWT = 85 - 72.4 = 12.6 °F

SUBJECT ECO #15 - EMCS

AEP NO

SHEET OF

RS&H®

DESIGNER

DATE

CHECKER

DATE

- ESTIMATE PAYBACK - CONDENSER WATER RESET

TO implement this function requires:

	Installed Cost (1)
• Chilled water temp sensor	$ 143
• Chiller water temp. control point adj.	200
• OSA temp. sensor	–
• Wiring (~$450/pt)	900
• Computer program	1500
	$ 2743
MARK-UP	1590
	$ 4334

EST. Payback $\frac{4333}{46}$ = 94 yr

Not Recommended

(1) See detailed cost estimate sheets in this section

RS&H	SUBJECT ECO #15 - EMCS	AEP NO	
		SHEET	OF
	DESIGNER	DATE	
	CHECKER	DATE	

Maintenance Savings

These calculations are based on DD Report Number CR 82.030, Standardized EMCS Energy Savings Calculations.

Run Time Recording (RTR):

By scheduling maintenance based on actual operation, assume the EMCS will save one man-visit per year to the system being monitored. Also assume each man-visit lasts 2 hours and a labor rate of \$25 per hour.

There are 11 AHU's that will be monitored.

$$\text{RTR Labor Savings} = 11\ \frac{\text{visits}}{\text{yr}} \times 2\ \frac{\text{Hr}}{\text{visit}} \times \$25/\text{hr} = \$550/\text{yr}$$

Safety Alarm (SA):

The EMCS can save time spent conveying alarm information and diagnosing problems. Assume a total of 2 hours per system per year.

$$\text{SA Labor Savings} = 11\ \text{syst.} \times 2\ \frac{\text{Hr}}{\text{syst}\cdot\text{yr}} \times 25\ \frac{\$}{\text{hr}} = \$550/\text{yr}$$

Total Labor Savings = RTR Savings + SA Savings

Total Labor Savings = \$550/yr + \$550/yr = $\underline{\underline{\$1{,}100/\text{yr}}}$

08/24/92

ECO Construction Cost Estimate
Calculations

ECO Name: ENERGY MONITORING AND CONTROL SYSTEM

ECO #: 15

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$209,300
Labor		$118,100
	Subtotal bare costs	$327,400
FICA Insurance (20% of Labor)		$23,620
Sales Tax (not applicable for GOGO)		$0
	Subtotal	$351,020
Overhead (15%)		$52,653
	Subtotal	$403,673
Profit (10%)		$40,367
	Subtotal	$444,040
Bond (1%)		$4,440
	Subtotal	$448,480
Contingency (10%)		$44,848
Subtotal (Construction Cost Input For LCCID *)		$493,328
SIOH (6% of Construction Cost)		$29,600
	Subtotal	$522,928
Design (6% of Construction Cost)		$29,600
Total Project Cost		$552,528

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

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Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared 2/18/92 | Sheet 1 of 15

District

Project EMCS

Location WATERVLIET ARSENAL

Basis for Estimate

- [X] Schematic Design
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other (Specify) ______

Note: Labor values shown are based on $25.00/hour incl. fringes

Estimator W. Todd

Checked by

Systems Equipment, FIDs MUX's and Enclosures Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
1. System Equipment Hardware - Complete** (For dual processor systems)*	1	PC LS (LS)	3,950 75,120 (102,215)	3,950	100 2250 (4212)	100	4050
2. Command Software	1	LS	37,400	37,400	XX	XX	37,400
3. Data Base Generation (Cost per Point)	151	POINT	XX	XX	18.50	2793	2793
4. Graphic Displays (per Diagram)	3	DIAG.	XX	XX	120	360	360
5. Applications Programs (From Work Sheet Table 2.11)	1	LS	5120	5120	XX	XX	5120
6. FID Hardware - Complete**	3	EA	5,450	16350	213	639	16989
7. FID Software (One Time Charge)	1	LS	5,750	5750	XX	XX	5750
8. MUX Hardware Complete**	7	EA	3,725	26075	113	791	26866
9. 120 Vac Power Circuit	41	EA	39	1599	88	3608	5207
10. Data Terminal Cabinet	7	EA	450	3150	25	175	3325
11. Remote Terminal Systems***	1	EA	3000	3000	50	50	3050
12. Large NEMA 1 I&C Enclosures	–	EA	150	-0-	23	-0-	-0-
13. Large NEMA 12 I&C Enclosures	3	EA	200	600	23	69	669
14. Small NEMA 4 & 13 I&C Enclosures	–	EA	50	-0-	13	-0-	-0-
15. FID Test Set	1	EA	18,718	18,718	200	200	18,918
16. FID Portable Tester	1	EA	7,500	7500	XX	XX	7500
PAGE TOTAL				129,212		8785	137,997

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* Use the cost in parenthesis for larger systems requiring dual processing with failover. The single processor figure is less one processor unit and the failover controller.

** The cost listed for the System Equipment includes all hardware, accessories, and power line conditioning, plus system software supplied by the computer manufacturer. The cost listed for FIDs and MUXs includes a power line conditioner. The FID cost does <u>not</u> include a separate MUX (see Figures 1-1 and 1-2).

*** The cost of remote CRTs and/or printers is the same as for those listed in Table 2.10. Assume a $50 (2 manhours) installation and set-up for each remote terminal. Material and labor costs must also be added for one Modem at the printer and one at the CLT, and for wireline DTM to connect between the CLT and the printer. These costs should be added on Sheet 2 of these cost estimating forms.

Remote Terminal

- CRT $1300
- Printer 700
- Modem (2) 1000

$3000

Programs

- Demand Limiting $2370
- Ventilation & Recirculation 1350
- Day/Night Setback 1400

TOTAL $5120

Energy Monitoring and Control Systems

Construction Cost Estimate

District	Date Prepared	Sheet 2 of 15
Project EMCS	Basis for Estimate	
Location WVA	___ Schematic Design ___ Preliminary Design ___ Final Design ___ Other (Specify) ______	
Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd	Checked by

Fiber Optic DTM* Summary	Quantity		Material ($)		Labor ($)	
	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total
Fiber Optic Cable - Aerial		1000'	910		1024	
Fiber Optic Cable - Direct Burial**		1000'	910		2081	
Fiber Optic Cable - Direct Burial (Chain Trencher)**		1000'	910		601	
Fiber Optic Cable - Existing Duct Bank		1000'	910		600	
Fiber Optic Cable - Indoor		1000'	910		450	
Subtotals for Cables	XX	LS	XX	-0-	XX	-0-
Fiber Optic Modem - (Receive and Transmit)		EA	300		100	
Fiber Optic Repeater		EA	250		50	
Transmitter Module		EA	125		25	
Receiver Module		EA	170		25	
Subtotals for Hardware	XX	LS	XX	-0-	XX	-0-
Page Totals	XX	XX	XX	-0-	XX	-0-
PAGE COST SUM						

Notes: *The Fiber Optic Cable is 4-fiber loose tube construction.
**This cable installation is not tamped for vibratory plate compaction add $253 per thousand linear feet (e.g. for direct burial w/chain trencher the total cost will be $854 per thousand linear feet)

Energy Monitoring and Control Systems

Construction Cost Estimate

District		Date Prepared	Sheet 3 of 15
Project	EMCS	Basis for Estimate	
Location	NVA	___ Schematic Design ___ Preliminary Design ___ Final Design ___ Other (Specify) ___	

Note: Labor values shown are based on $25.00/hour incl. fringes		Estimator W. Todd		Checked by		
	Quantity		Material ($)		Labor ($)	
Wireline DTM Summary	No. Units	Unit Meas.	Per Unit	Total	Per Unit	Total
Wireline Cable - Aerial	—	1000'	630	-0-	1024	-0-
Wireline Cable - Direct Burial	—	1000'	650	-0-	2413	-0-
Wireline Cable - Direct Burial (Chain Trencher)* MAT LAB	3.8 0.8	1000'	650	2470	601	481
Wireline Cable - Existing Duct Bank MAT LAB	37.0 20.4	1000'	510	18870	600	12240
Wireline Cable - Indoor MAT LAB	37.2 8.9	1000'	510	18,972	450	4005
Subtotal for Cables	XX	LS	XX	40108	XX	16546
Modem	7	EA	500	3500	45	315
Line Driver	—	EA	225	-0-	40	-0-
Subtotal for Hardware	XX	LS	XX	3500	XX	315
Page Totals	XX	XX	XX	43312	XX	17041
PAGE COST SUM				60,853		

Note: *This cable installation is not tamped; for vibratory plate compaction add $253 per thousand linear feet (e.g. for direct burial w/chain trencher the total cost will be $854 per thousand linear feet).

Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared

District

Project EMCS

Location WVA

Basis for Estimate

- [ ] Schematic Design
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other (Specify) ________

Note: Labor values shown are based on $25.00/hour incl. fringes

Estimator W. Todd

Checked by

Coaxial Cable DTM Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total
Coaxial Cable - Aerial		1000'	490		1024	
Coaxial Cable - Direct Burial*		1000'	490		2413	
Coaxial Cable - Direct Burial (Chain Trencher)*		1000'	490		601	
Coaxial Cable - Existing Duct Bank		1000'	230		600	
Coaxial Cable - Indoor		1000'	230		450	
Subtotal for Cables	XX	LS	XX	-0-	XX	-0-
Coaxial Cable Modem		EA	610		150	
Coaxial Amplifier		EA	650		100	
Subtotal for Hardware	XX	LS	XX	-0-	XX	-0-
Page Totals	XX	XX	XX	-0-	XX	-0-
PAGE COST SUM						

Note: *This cable installation is not tamped; for vibratory plate compaction add $253 per thousand linear feet (e.g., for direct burial w/chain trencher the total cost will be $854 per thousand linear feet).

Energy Monitoring and Control Systems

Construction Cost Estimate

District		Date Prepared	Sheet 5 of 15
Project EMCS		Basis for Estimate	
Location WVA		☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) ______	
Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd	Checked by	

Two-Way Radio DTM Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
Headend Transceiver	–	EA	5,145		13		
Headend Antenna	–	EA	585		25		
Radio Tower	–	EA	1,220		1,050		
Repeater	–	EA	6,930		38		
Duplexer	–	EA	775		38		
9.5 dB Remote Antenna	–	EA	225		25		
2.5 dB Remote Antenna	–	EA	65		25		
Remote Transceiver	–	EA	725		13		
Page Total (Hardware)	XX	XX	XX	-0-	XX	-0-	-0-

NOTE:

Modems and Coaxial Cable will be required for a two-way radio system as illustrated in Figure 2-2. Add the Modems and the Coaxial Cable (for long runs) on Sheet 3 of these cost estimating forms.

If the antenna or towers are located within 100 feet of the headend transceiver, the cost of the coaxial cable may be ignored.

Energy Monitoring and Control Systems

Construction Cost Estimate

District	Date Prepared	Sheet 6 of 15
Project EMCS	Basis for Estimate	
Location WVA	☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) ______	
Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd	Checked by

Analog Inputs Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
1. Space Temperature: RTD and Transmitter	30	EA	125	3750	35	1050	4800
2. Outside Air Temperature: RTD and Transmitter	3	EA	130	390	55	165	555
Instrument Shelter	3	EA	350	1050	45	135	1185
3. Duct (Point) Temperature: RTD and Transmitter	–	EA	130		55		-0-
4. Liquid Temperature: RTD and Transmitter (Cu Thermowell: Add $20 for Stainless Steel Thermowell)	–	EA	210		38		-0-
5. Liquid Level Sensor	–	EA	1,037		80		-0-
6. Pos. Displacement Flowmeter	–	EA	2,353		245		-0-
7. Duct Average Temperature: RTD and Transmitter	–	EA	200		105		-0-
8. Space or OA Relative Humidity: Sensor and Transmitter	–	EA	450		35		-0-
9. Duct Relative Humidity: Sensor and Transmitter	–	EA	450		55		-0-
10. Gauge Pressure Transmitter (Liquid) (W/Pressure Tap)	—	EA	465		147		-0-
Page Total				5190		1350	6540

NOTE:
Each item cost includes the sensor, transmitter along with associated common costs (e.g., conduit, wiring, terminations) as stated previously in Paragraphs 3.1, 3.2, and 3.3.

Energy Monitoring and Control Systems

Construction Cost Estimate

District		Date Prepared		Sheet 7 of 15
Project EMCS		Basis for Estimate		
Location NVA		___ Schematic Design ___ Preliminary Design ___ Final Design ___ Other (Specify) ________		
Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd		Checked by	

Analog Inputs Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
11. Differential Pressure Transmitter (Liquid) (incl. 2 Pressure Taps)	—	EA	670		260		-0-
12. 1-Phase Electric Power: (incl. CT, PT, Watt Transducer Set) with Split-Coil CT*	—	EA EA	480 510		93 84		-0-
13. 3-Phase Electric Power: (CT, PT, Watt Transducer Set) with Split Coil CT's*	1	3-EA	750 1,170	1170	197 170	170	1340
14. Current Transducer	—	3-EA	458		231		-0-
15. Voltage Transducer	—	2-EA	538		231		-0-
16. VAR Transducer (1 Phase)	—	EA	818		231		-0-
17. VAR Transducer (3 Phase)	—	EA	1,048		283		-0-
18. PF Transducer	—	EA	665		244		-0-
19. Valve Position: Linear Potentiometer	—	EA	210		73		-0-
20. Damper Position: Rotary Potentiometer	11	EA	210	2310	73	803	3113
Page Total		XXX	XXX	3480	XXX	973	4453

NOTE:
Each item accounts for the sensor, transmitter/transducer and common costs (general costs are estimated on Sheets 12 and 13 of these cost estimating forms). See also paragraphs 3.1, 3.2, 3.3, and Appendix C.

* Use one case or the other as applicable; do not add.

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Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared		Sheet 8 of 15
District	Basis for Estimate	
Project EMCS	Schematic Design Preliminary Design Final Design Other (Specify)	
Location WVA		

Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd		Checked by			

Digital Inputs — Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
1. Space Temperature Switch	–	EA	105		38		-0-
2. Liquid Temperature Switch (Copper Thermowell: Add $20 for Stainless Steel Thermowell)	–	EA	155		143		-0-
3. Gauge Pressure Switch (Liquid) (W/Pressure Tap)	2	EA	155	310	147	294	604
4. Differential Pressure (DP) Switch (Liquid) (W/Pressure Taps)	–	EA	225		260		-0-
5. Differential Pressure DP Switch (Air)	2	EA	70	140	48	96	236
6. Liquid Flow Switch (W/Pipe Fittings)	–	EA	145		113		-0-
7. Liquid Level Switch	–		636		80		-0-
8. 1-Phase Electric Power (incl. CT, PT, Meter Socket) W/Split Coil CT* Meter W/Pulse Initiator, Add	–	EA EA	560 700 375		118 109 13		-0-
9. 3-Phase Electric Power (CT, PT, Meter Socket) W/Split Coil CT's* Meter W/Pulse Initiator, Add	–		400 820 575		210 183 13		-0-
10. Motor Current Status (CT, Sensing Relay) W/Split Coil CT*	–		85 225		58 49		-0-
Page Total				450		390	840

* Use one case or the other as applicable; do not add.

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Energy Monitoring and Control Systems

Construction Cost Estimate

Date Prepared	Sheet 9 of 15
District	Basis for Estimate
Project EMCS	☐ Schematic Design ☐ Preliminary Design ☐ Final Design ☐ Other (Specify) ____
Location NWA	
Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd · Checked by

Digital Inputs Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
11. Status Monitoring Auxiliary Contacts (Limit Switch)	38	EA	15	570	25	950	1520
12. 3-Phase Electric Metering 12 KV Installation	—	EA	2,745		200		-0-
13. Adjust Material Cost For Actual Voltage (KV Difference)	—	KV EA	110		--		-0-
14. 3-Phase Electric Metering 34.5 KV Installation	—	EA	4,360		367		-0-
15. Adjust Material Cost for Actual Voltage (KV Difference)	—	KV EA	275		---		-0-
Page Total				570		950	1520

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Energy Monitoring and Control Systems

Construction Cost Estimate

District	Date Prepared	Sheet 10 of 15
Project EMCS	Basis for Estimate	
Location WVA	__ Schematic Design __ Preliminary Design __ Final Design __ Other (Specify) ______	
Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd	Checked by

Analog Outputs Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
1. Control Point Adjustment Pneumatic CPA Controller (Fixed Failure Mode)*	–	EA	.130 335		70		-2-
2. Position Adjustment (Fixed Failure Mode)*	–		205		25		-2-
3. Damper Motor Actuator	11	EA	182	2002	25	275	2277
4. PID Controller	11	EA	400	4400	100	1100	5500
Page Total				6402		1375	7777

(1) "Fixed Failure Mode" includes high value, low value, and local loop. Since this function requires a failover EP valve, the same quantity must be added to the Digital Outputs estimating sheet to account for costs of the EP valve control output.

(2) See the note on Sheet 7 of these cost estimating forms in reference to the addition of common costs.

(3) Items 1 and 2 include I-P Converters, Control Relays, EP Valves, and Pressure Regulators.

Energy Monitoring and Control Systems

Construction Cost Estimate

District	Date Prepared	Sheet 11 of 15
Project EMCS	Basis for Estimate	
Location WVA	__ Schematic Design __ Preliminary Design __ Final Design __ Other (Specify) ______	

Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd	Checked by

Digital Outputs Summary	Quantity No. Units	Quantity Unit Meas.	Material ($) Per Unit	Material ($) Total	Labor ($) Per Unit	Labor ($) Total	Total Cost
1. Control Relay Output (CR)	12	EA	87	1044	25	300	1344
							-0-
2. Solenoid (EP Valve) Control (CR, EP Valve, Pr. Reg.)	30	EA	302	9060	75	2250	11,310
3. Contactor Control 60 Amp (Control Relay) W/100 Amps Contactor**	—	EA EA	412 557		75 60		-0-
4. Control Point Adjustment (Fail to last command)* (CR, Motorized Pot., Current Transducer, CPA Controller, and I-P Converter incl.)***	—		930		183		-0-
5. Steam Control Valve, 4" Flanged, Iron Body, Pneumatic Operated.	4	EA	2530	10120	120	480	10600
Page Total				20,224		3030	23,254

* Although the CPA with "fail to last command" is listed on the I/O summary sheet as an analog output, it is often implemented by two (raise, lower) digital outputs. For this special case, the quantity must be multiplied by two.

** Use one or the other as appropriate; do not add.

*** See the note on Sheet 7 of these cost estimating forms in reference to the addition of common costs.

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Energy Monitoring and Control Systems

Construction Cost Estimate

District	Date Prepared	Sheet 12 or 15
Project EMCS	Basis for Estimate	
Location WVA	___ Schematic Design ___ Preliminary Design ___ Final Design ___ Other (Specify) ______	
Estimator W. Todd	Checked by	

General Costs and Sales Taxes Summary	Mat'L Total	Labor Total	Total Cost
1. Equipment Cost Summary (Maintenance Cost)			
System Equipment Hardware (Sheet 1 Item 1)	3950	100	4050
FID Hardware (Sheet 1, Items 6, 15, & 16)	42568	839	43407
MUX Hardware (Sheet 1 Items 8 & 10)	29225	966	30191
Data Transmission H/W (Sheets 2, 3, 4, & 5)	3500	315	3815
Total Equipment Cost	79,243	2,220	81,463

2. First Year Maintenance:
11% of Item 1 Total Cost (Material plus Labor)

($ 8961) Do not add this cost to the total construction cost. This information shall be given to the installation for O&M funds planning.

3. Total Material Cost Summary (Sales Taxes)			
Total Equipment Material Cost (From Item 1 Above)	79,243	2,220	81,463
I&C Enclosures (Sheet 1 Items ~~10~~ (12) thru 14)	600	69	669
Data Transmission Cables (Sheets 2, 3, & 4)	40312	16,726	57,038
120 Vac Power Circuits (Sheet 1, Item 9)	1599	3608	5207
Total Material Cost	121,754	22,623	144,377
4. Sales Taxes on Materials: (0)% of Item 3 Mat'l Total			-0-
5. Employer's Burden: (20)% of Item 3 Labor Total			4525
Page Total			148,902

Construction Cost Estimate

District	Date Prepared	Sheet 13 of 15
Project EMCS	Basis for Estimate __ Schematic Design __ Preliminary Design __ Final Design __ Other (Specify) ____	
Location WVA		
	Estimator W. Todd	Checked by

General Costs and Sales Taxes Summary	Mat'L Total	Labor Total	Total Cost
6. Technical Data Packages (From Table 2.1) 151 pts	—	26,205	26,205
7. Testing* (From Table 2.2) 58 Analog Pts. 93 Digital Pts.	—	33,263	33,263
8. Training (From Table 2.3) 10 students	—	20250	20250
Page Total	-0-	79,718	79,718

* The estimator should determine the point mix (analog and digital) and make any necessary adjustments to the cost of the Contractor's Field Testing.

Energy Monitoring and Control Systems

Construction Cost Estimate

	Date Prepared	Sheet 14 of 15
District	Basis for Estimate __ Schematic Design __ Preliminary Design __ Final Design __ Other (Specify) ______	
Project EMCS		
Location WVA		
Estimator W. Todd	Checked by P. Hutchins	

Cost Summary	Mat'L Total	Labor Total	Total Cost
1. Total Installed Direct Cost of EMCS (Sum of page totals, sheets 1-11; sheets 12 & 13 Items 4-8	209,340	118,137	327,477
1A. Correction of EMCS Labor Costs for Project Location: Multiply Labor Cost by (1.0).*	209,340	118,137	327,477
2. Contractor's Overhead at (15)( )% of Item 1A.			
3. Contractor's Profit at (10) ( )% of Item 1A.			
4. Performance Bond at (1) ( )% of Item 1A.			
5. S & A Allowance at ~~(5.5)~~ (6.0)% of Item 1A.			
6. Contingencies at (10) ( )% of Item 1A.			
7. Design at 6.0% of Item 1A			
SEE PAGE 15-21 for mark-ups			
EMCS Total Construction Cost			

* To determine this factor, the estimator must first determine the prevailing local labor rate (whether Union or Davis-Bacon). If, for instance, the local rate is $32, this factor is ($32/$25) - (1.28).

Energy Monitoring and Control Systems

Construction Cost Estimate

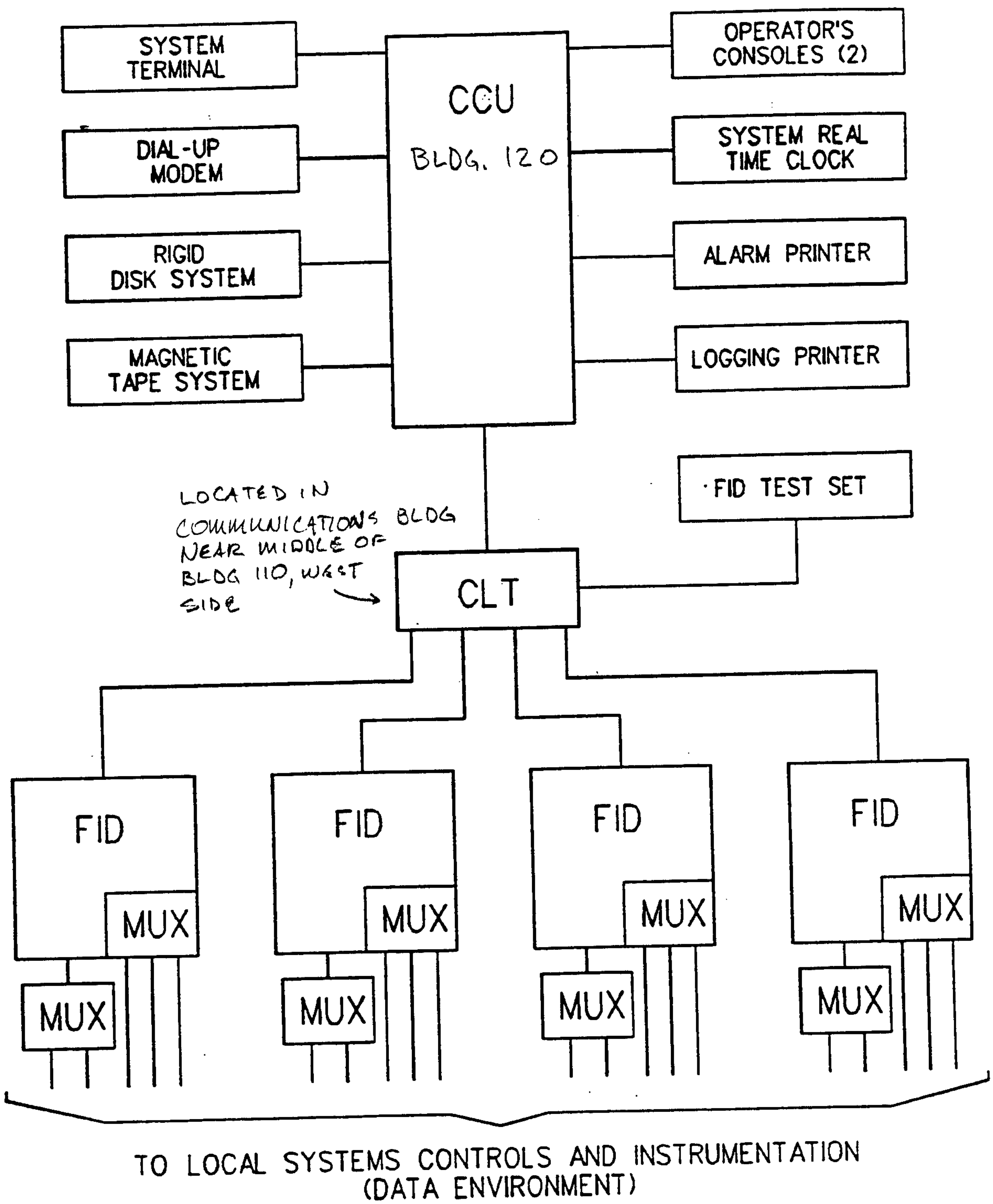
District	Date Prepared	Sheet 15 of 15
Project EMCS	Basis for Estimate	
Location WVA	___ Schematic Design ___ Preliminary Design ___ Final Design ___ Other (Specify) ________	
Note: Labor values shown are based on $25.00/hour incl. fringes	Estimator W. Todd	Checked by

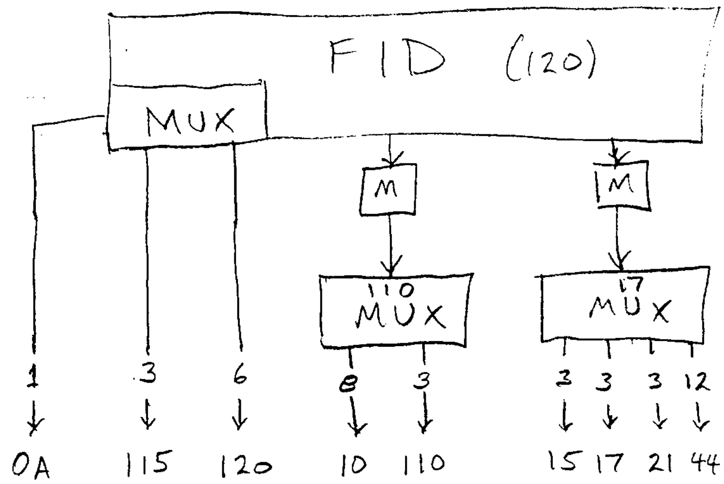
Related Cost Summary	Mat'L Total	Labor Total	Total Cost
1. Associated General Construction Lump Sum Cost (Sheet 14 total)			
2. Electrical Equipment Modifications Lump Sum Cost*			
3. Mechanical Equipment Modifications Lump Sum Cost*			
4. Existing Controls Repair Lump Sum Cost			
Total Costs			

* The cost listed should include an additional allowance for Operations & Maintenance documentation. Present guidelines suggest 3% of construction cost be allocated for electrical and mechanical construction. For the EMCS itself, the cost of documentation is specifically addressed on Sheet 13 of these cost estimating forms (Item 6).

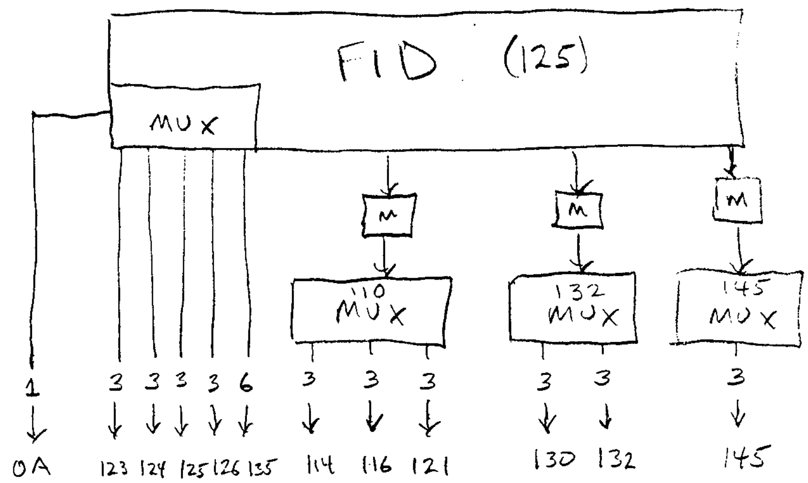
FIGURE 1-1

MEDIUM EMCS BLOCK DIAGRAM

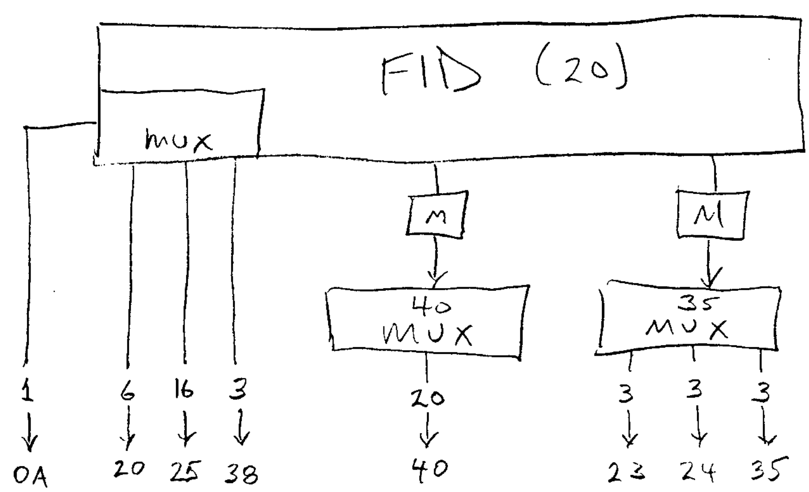




1 FID
2 MODEM
2 MUX
42 Points
8 Bldgs



1 FID
3 MODEM
3 MUX
37 Points
11 Bldgs



1 FID
2 MODEM
2 MUX
55 Points
7 Bldgs

SUBJECT ECO #15 - EMCS

AEP NO

SHEET OF

RS&H®

DESIGNER

DATE

CHECKER

DATE

Project Implementation Costs

The following sources were used to estimate the EMCS acquisition and installation costs:

1. EMCS, Large and Medium Configurations, Cost Estimating Guidelines, US Army Corps of Engineers, Huntsville Division, 12/90.

2. Means Mechanical Cost Data, 1991

3. Omega Engineering Catalog

All necessary control points are listed on the next 2 pages. The cost summary for these control points by function is contained on p. 15-43 and individually on p. 15-29 through 15-34.

Pages 15 through 30 contain the construction cost estimate worksheets.

ECO #15 - EMCS

Watervliet Arsenal - EMCS System & Points Schedule
File Name: EMSLIST.WQ1
Date: 03/02/92

Bldg	Area	System	Control	Total Pts	OUTPUT CRO	SOL	DMA	PID	INPUT GPS	DPS	LIM	STS	POS	OAT	Control Valve	120 VAC Power
10	Repro	AHU-SZ,DX		0												
	ADPS	AHU-SZ,DX		0												
	Compu	AHU-SZ,DX		0												
	Admin N	AHU-VAV	VR	3	0	0	1	1	0	0	0	0	1	0		
	Admin S	Convert-HW	SBV&SBP	5	1	1	0	0	1	0	1	1	0	0	1	1
15	Admin	AHU-SZ,DX		0												
	Shop	UnitHt-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
17	Grounds	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
20	Admin	AHU-VAV	VR	4	0	0	1	1	0	0	0	0	1	1		
	Admin	Radiat-Stm		0												
	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
21	Cafe	AHU-HV		0												
	Cafe	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
22	Fire Sta	Radiat-Stm		0												
23	Admin 1st	Radiat-Stm	SBV	3	0	1	0	0	0	0	1	1	0	0	1	1
24	Admin	AHU-SZ,DX		0												
	Admin	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Compu	AHU-SZ,DX		0												
25	Admin	AHU-VAV	VRF	5	1	0	1	1	0	1	0	0	1	0		
	Admin	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Admin	AHU-VAV	VRF	5	1	0	1	1	0	1	0	0	1	0		
	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Compu	AHU-SZ,DX		0												
35	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Class Rm	AHU-SZ,DX		0												
38	Museum	Radiat-Stm	SBV	3	0	1	0	0	0	0	1	1	0	0	1	1
	Museum	AHU-SZ,DX		0												
40	MicroFilm	AHU-SZ,DX	VR	3	0	0	1	1	0	0	0	0	1	0		
	CADD	AHU-SZ,DX	VR	3	0	0	1	1	0	0	0	0	1	0		
	Admin	Chiller-AC		0												
	Admin 1	AHU-SZ	VR	3	0	0	1	1	0	0	0	0	1	0		
	Admin 1	Convert-HW	SBP	2	1	0	0	0	1	0	0	0	0	0		
	Admin 2	AHU-SZ	VR	3	0	0	1	1	0	0	0	0	1	0		
	Draft	AHU-SZ,DX		0												
	N-Conf	AHU-SZ,DX		0												
	S-Conf	AHU-SZ,DX		0												
	Clinic	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Employ	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
44	Admin	AHU-SZ	VR	3	0	0	1	1	0	0	0	0	1	0		
	Admin	Chiller-AC		0												
	Admin E	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Admin W	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Labs	AHU-SZ		0												
	Labs	Chiller-AC		0												
	Compu	AHU-SZ,DX		0												
	Basmt	AHU-HV	VR	3	0	0	1	1	0	0	0	0	1	0		

110	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
114	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
115	Admin	AHU-SZ		0												
	Admin	AHU-HV		0												
	Admin	AHU-HV		0												
	Admin	Radiat-Stm	SBV	3	0	1	0	0	0	0	1	1	0	0	1	1
	Compu	AHU-SZ,DX		0												
116	POL	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
120	Admin	AHU-MZ	VR	4	0	0	1	1	0	0	0	0	1	1		
	Admin	Chiller-AC		0												
	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	C&W Labs	AHU-SZ		0												
	C&W Labs	Chiller-AC		0												
	E Labs	AHU-HV		0												
	E Labs	Chiller-AC		0												
121	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
123	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
124	Lab	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
125	Shop	Radiat-Stm	SB	4	0	1	0	0	0	0	1	1	0	1		1
126	Storage	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
130	Storage	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
132	Pest	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
135	Shop	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
	Office	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
145	Storage	Radiat-Stm	SB	3	0	1	0	0	0	0	1	1	0	0		1
		Totals		134	4	30	11	11	2	2	30	30	11	3	4	30

Control Point Legend:

- CRO - Control Relay Output
- SOL - Solenoid
- DMA - Damper Motor Actuator
- PID - PID Controller
- GPS - Gage Pressure Switch
- DPS - Differential Pressure Switch
- LIM - End Limit Switch
- STS - Space Temperature Sensor ('F)
- POS - Damper Position Indicator
- OAT - Outside Air Temp. Sensor ('F)

Controlled System Legend:

- AHU - Air Handling Unit
- AHU-HV - AHU, Heating & Ventilating
- AHU-MZ - AHU, Multi-Zone
- AHU-SZ - AHU, Single Zone
- AHU-SZ,DX - AHU, Single Zone, Direct Exp.
- AHU-VAV - AHU, Variable Air Volume
- Chiller-AC - Chiller, Air Cooled
- Convert-HW - Converter, Steam to Hot Water
- Radiat-Stm - Radiators, Steam
- UnitHt-Stm - Unit Heater, Steam

EMCS Function Legend:

- SB - Day/Night Setback of Steam Valve
- SBV - SB With New Control Valve
- SBP - Setback Pump
- VR - Ventilation/Recirculation
- VRF - V/R With Exhaust Fan Control

CONSTRUCTION COST ESTIMATE	DATE PREPARED 3-20-92	SHEET OF

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WATERVLIET ARSENAL

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE:
- ☐ CODE A (No design completed)
- ☒ CODE B (Preliminary design)
- ☐ CODE C (Final design)
- ☐ OTHER (Specify)

DRAWING NO.: N/A | ESTIMATOR: W. T. Todd | CHECKED BY:

EMCS SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
SETBACK - STEAM							
INPUT							
Space Temp. Sensor (A)	30	Ea.	35	1050	125	3750	4800
End Limit Switch (D)	30	Ea.	25	750	15	450	1200
OUTPUT							
Solenoid (D)	30	Ea.	75	2250	302	9060	11310
120 Volt AC Power	30	Ea.	88	2640	39	1170	3810
Pneumatic Steam Valve, 4"	4	Ea.	120	480	2530	10120	10600
				7170		24550	31720
VENTIL. & RECIRC.							
INPUT							
Differential Press. Switch (D)	2	Ea.	48	96	70	140	236
Damper Pos. Ind. (A)	11	Ea.	73	803	210	2310	3113
OUTPUT							
Damper Motor Actuator (A)	11	Ea.	25	275	182	2002	2277
Control Relay (D)	2	Ea.	25	50	87	174	224
PID Controller	11	Ea.	100	1100	400	4400	5500
				2324		9026	11350
SETBACK - PUMP							
INPUT							
Gage Pressure Switch (D)	2	Ea.	147	294	155	310	604
OUTPUT							
Control Relay (D)	2	Ea.	25	50	87	174	224
				344		484	828

ENG FORM 1 AUG 59 150 (ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE, 1959 O—510140

WVA - EMS Wire Line Distances (In Feet)
Filename: EMSCABL2.W01

		CLT-FID			FID-MUX			MUX-PTS				MUX-PTS TOTAL		
	Bldg	Duct	Bury	Bldg	Duct	Bury	Bldg	Duct	Bury	Bldg	Points	Duct	Bury	Bldg
FID 1	20	2600	0	200	0	0	0	0	0	300	7	0	0	2100
	25	0	0	0	0	0	0	300	0	300	16	4800	0	4800
	38	0	0	0	0	0	0	225	100	150	3	675	300	450
MUX 1	35	0	0	0	1000	0	400	0	0	400	3	0	0	1200
	23	0	0	0	0	0	0	0	0	400	3	0	0	1200
	24	0	0	0	0	0	0	0	0	300	3	0	0	900
MUX 2	40	0	0	0	875	0	400	0	0	400	20	0	0	8000
	Subtotal	2600	0	200	1875	0	800	525	100	2250	55	5475	300	18650
FID 2	120	5300	0	250	0	0	0	0	0	200	7	0	0	1400
	115	0	0	0	0	0	0	50	50	200	3	150	150	600
MUX 1	17	0	0	0	1150	0	250	0	0	100	3	0	0	300
	15	0	0	0	0	0	0	275	50	150	3	825	150	450
	21	0	0	0	0	0	0	50	50	150	3	150	150	450
	44	0	0	0	0	0	0	300	0	200	12	3600	0	2400
MUX 2	110	0	0	0	375	0	300	0	0	400	3	0	0	1200
	10	0	0	0	0	0	0	50	300	200	8	400	2400	1600
	Subtotal	5300	0	250	1525	0	550	725	450	1600	42	5125	2850	8400
FID 3	125	875	0	300	0	0	0	0	0	350	4	0	0	1400
	123	0	0	0	0	0	0	500	0	150	3	1500	0	450
	124	0	0	0	0	0	0	325	0	150	3	975	0	450
	126	0	0	0	0	0	0	325	0	150	3	975	0	450
	135	0	0	0	0	0	0	625	0	300	6	3750	0	1800
MUX 1	110	0	0	0	875	0	300	0	0	0	0	0	0	0
	114	0	0	0	0	0	0	75	0	100	3	225	0	300
	116	0	0	0	0	0	0	300	50	100	3	900	150	300
	121	0	0	0	0	0	0	250	50	100	3	750	150	300
MUX 2	132	0	0	0	1350	0	150	0	0	50	3	0	0	150
	130	0	0	0	0	0	0	300	100	150	3	900	300	450
MUX 3	145	0	0	0	2050	0	200	0	0	300	3	0	0	900
	Subtotal	875	0	300	4275	0	650	2700	200	1900	37	9975	600	6950
	TOTAL	8775	0	750	7675	0	2000	3950	750	5750	134	20575	3750	34000

	Material	Labor
Existing Duct Bank	37025 Feet	20400 Feet
Direct Burial	3750 Feet	750 Feet
Indoor	36750 Feet	8500 Feet

WVA - EMCS Cable Distances
Existing Duct Banks
Filename: EMSCABL2.WQ1

Run Number	Manhole No.s From #	To #	Plan Inches	Act. Feet
1	2	1	1.125	225
2	3	2	0.875	175
3	4	3	0.750	150
4	5	4	0.750	150
5	5	5 A	0.500	100
6	5 A	38	1.000	200
7	6	5	1.125	225
8	7	6	0.875	175
9	8	7	1.375	275
10	9	8	1.125	225
11	10	9	0.750	150
12	11	10	0.375	75
13	12	11	0.375	75
14	12	14	1.250	250
15	14	15	0.750	150
16	15	16	1.000	200
17	16	17	1.000	200
18	17	18	0.375	75
19	18	19	0.875	175
20	19	19 A	1.000	200
21	19	20	1.500	300
22	19 A	19 B	1.000	200
23	19 B	19 C	0.875	175
24	19 C	60	1.375	275
25	20	22	0.750	150
26	20	32	2.000	400
27	22	23	1.125	225
28	32	33	1.500	300
29	33	34	0.750	150
30	34	5	0.125	25
31	42	41	1.625	325
32	43	42	1.250	250
33	44	43	1.125	225
34	44	46	1.500	300
35	46	47	1.375	275
36	52	44	2.000	400
37	53	52	0.500	100
38	54	53	1.250	250
39	55	54	1.250	250
40	55	55 A	1.375	275
41	56	55	1.375	275
42	57	56	1.625	325
43	57	57 A	1.125	225
44	58	57	1.500	300
45	59	58	1.750	350
46	60	59	1.750	350

BUILDING NO. 10	HARDWARE																				SOFTWARE																												
SYSTEM(S) STEAM HW CONVERTOR	OUTPUT								INPUT												ALARMS							APPLICATION PROGRAMS																					
OCCUPANCY TIME	DIGITAL					ANALOG			DIGITAL							ANALOG					DIGITAL			ANALOG																									
GRAPHIC DISPLAY ● / POINT DESCRIPTION	CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO		CONTROL POINT ADJUSTMENT			PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE	END (LIMIT) SWITCH		TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW	CONTACT CLOSURE			HIGH LIMIT	LOW LIMIT	RUN TIME		SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL				FAILURE MODE * *
STEAM HW CONVERTOR																																																	
HW SUPPLY						●										●								●	●			●	●			■							●										N
PUMP	■								■												●					●			●	●		■																	C
SPACE SENSOR																■								●	●																								
STEAM SUPPLY VALVE		■												■																																			
OUTSIDE AIR *																●																																	

* ONE MEASUREMENT FOR ENTIRE SYSTEM
* * C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Table 4-20. I/O summary table for steam/HW converter.

15-46

BUILDING NO's 10 & 20	HARDWARE																				SOFTWARE																												
SYSTEM(S) VARIABLE AIR VOLUME AHU	OUTPUT								INPUT												ALARMS							APPLICATION PROGRAMS																					
OCCUPANCY TIME	DIGITAL					ANALOG			DIGITAL							ANALOG					DIGITAL			ANALOG																									
GRAPHIC DISPLAY ● / POINT DESCRIPTION	CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO		CONTROL POINT ADJUSTMENT	MOTOR ACTUATOR	PID CONTROLLER	PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE			TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION - Damper	FLOW	CONTACT CLOSURE			HIGH LIMIT	LOW LIMIT	RUN TIME		SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL				FAILURE MODE * *
VAV AHU																																																	
SUPPLY FAN	●									●											●					●		●	●		●	●																	O
RETURN FAN										●											●																												
O. A. DAMPER				●			■	■											■													●	●	■															N
MIXED AIR																●								●	●																								
SUPPLY AIR																●								●	●																								
RETURN AIR																●	●							●	●																								
SPACE																●	●							●	●				●	●		●																	
FILTER										●											●																												
OUTSIDE AIR * (1)																■	●																																

* ONE MEASUREMENT FOR ENTIRE SYSTEM
* * C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Note (1) - Outside Air temp. Sensor is for Bldg. 20 only.

Table 4-3. I/O summary table for variable air volume AHU.

15-47

BUILDING NO. 15	HARDWARE																			
SYSTEM(S) STEAM UNIT HEATER	OUTPUT								INPUT											
OCCUPANCY TIME	DIGITAL					ANALOG			DIGITAL							ANALOG				
GRAPHIC DISPLAY ● / POINT DESCRIPTION	CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO		CONTROL POINT ADJUSTMENT			PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE	END (LIMIT) SWITCH		TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW
STEAM UNIT HEATER																				
STEAM SUPPLY VALVE		■												■						
SPACE																■				
OUTSIDE AIR *																●				

BUILDING NO. 15	SOFTWARE																												
SYSTEM(S) STEAM UNIT HEATER	ALARMS							APPLICATION PROGRAMS																					
OCCUPANCY TIME	DIGITAL			ANALOG																									
GRAPHIC DISPLAY ● / POINT DESCRIPTION	CONTACT CLOSURE			HIGH LIMIT	LOW LIMIT	RUN TIME		SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL				FAILURE MODE **
STEAM UNIT HEATER																													
STEAM SUPPLY VALVE												■																	C
SPACE				●	●							■																	
OUTSIDE AIR *																													

* ONE MEASUREMENT FOR ENTIRE SYSTEM
** C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Table 4-10. I/O summary table for steam unit heater.

15-48

BUILDING NO'S See list below

SYSTEM(S) STEAM RADIATION

OCCUPANCY TIME

GRAPHIC DISPLAY ●

POINT DESCRIPTION	HARDWARE / OUTPUT / DIGITAL: CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO	OUTPUT / ANALOG: CONTROL POINT ADJUSTMENT	INPUT / DIGITAL: PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE	END (LIMIT) SWITCH	INPUT / ANALOG: TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW
STEAM RADIATION																
STEAM SUPPLY VALVE		■									■					
SPACE												■				
OUTSIDE AIR * (1)												■				

POINT DESCRIPTION	SOFTWARE / ALARMS / DIGITAL: CONTACT CLOSURE	ALARMS / ANALOG: HIGH LIMIT	LOW LIMIT	RUN TIME	APPLICATION PROGRAMS: SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA PESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL	FAILURE MODE * *
STEAM RADIATION																							C
STEAM SUPPLY VALVE									■														
SPACE		●	●						■														
OUTSIDE AIR * (1)																							

* ONE MEASUREMENT FOR ENTIRE SYSTEM
* * C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Table 4-13. I/O summary table for steam radiation.

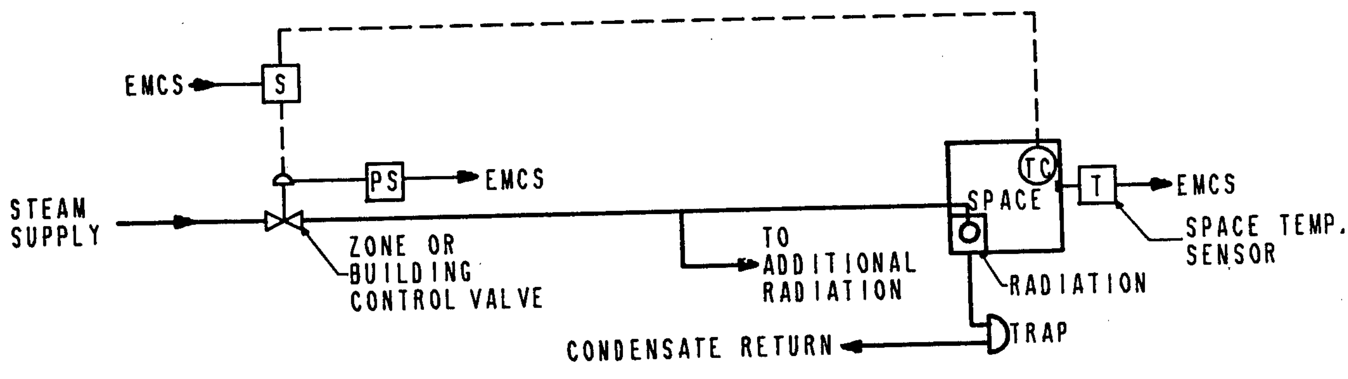


Figure 4-13. Steam radiation schematic.

Applies to the following Buildings:

20	~~[illegible]~~	35	121	126	40	135
23	17	110	123	130	44	
25	21	114	124	132	115	
38	24	116	125	145	120	

Note (1) - Outside air temp. sensor is for Bldg. 125 only

15-49

BUILDING NO. 25

SYSTEM(S)

VARIABLE AIR VOLUME AHU

OCCUPANCY TIME

GRAPHIC DISPLAY ●

HARDWARE

POINT DESCRIPTION	OUTPUT DIGITAL: CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO	OUTPUT ANALOG: CONTROL POINT ADJUSTMENT	MOTOR ACTUATOR	PID CONTROLLER	INPUT DIGITAL: PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE	INPUT ANALOG: TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW
VAV AHU																	
SUPPLY FAN	●								●								
RETURN FAN									●								
O. A. DAMPER				●		■	■									■	
MIXED AIR													●				
SUPPLY AIR													●				
RETURN AIR													●	●			
SPACE													●	●			
FILTER									●								
EXHAUST FAN	■								■								
OUTSIDE AIR *													●	●			

SOFTWARE

POINT DESCRIPTION	ALARMS DIGITAL: CONTACT CLOSURE	ALARMS ANALOG: HIGH LIMIT	LOW LIMIT	RUN TIME	APPLICATION PROGRAMS: SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	FAILURE MODE * *
VAV AHU												
SUPPLY FAN	●			●	●	●		●	●			O
RETURN FAN	●											
O. A. DAMPER									●	●	■	N
MIXED AIR		●	●									
SUPPLY AIR		●	●									
RETURN AIR		●	●									
SPACE		●	●			●	●		●			
FILTER	●											
EXHAUST FAN												
OUTSIDE AIR *												

POINT DESCRIPTION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL
VAV AHU											
SUPPLY FAN											
RETURN FAN											
O. A. DAMPER											
MIXED AIR											
SUPPLY AIR											
RETURN AIR											
SPACE											
FILTER											
EXHAUST FAN											
OUTSIDE AIR *											

* ONE MEASUREMENT FOR ENTIRE SYSTEM

* * C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Table 4-3. I/O summary table for variable air volume AHU.

15-50

BUILDING NO. 40

SYSTEM(S)
STEAM HW CONVERTOR

OCCUPANCY TIME

GRAPHIC DISPLAY ●

	HARDWARE																				SOFTWARE																												
	OUTPUT								INPUT												ALARMS							APPLICATION PROGRAMS																					
	DIGITAL					ANALOG			DIGITAL							ANALOG					DIGITAL			ANALOG																									
POINT DESCRIPTION	CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO		CONTROL POINT ADJUSTMENT			PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE			TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW	CONTACT CLOSURE			HIGH LIMIT	LOW LIMIT	RUN TIME		SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL				FAILURE MODE * *
STEAM HW CONVERTOR																																																	
HW SUPPLY						●										●								●	●			●	●			●							●										N
PUMP	■								■												●					●			●	●		■																	C
SPACE SENSOR																●								●	●																								
OUTSIDE AIR *																●																																	

* ONE MEASUREMENT FOR ENTIRE SYSTEM
* * C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Table 4-20. I/O summary table for steam/HW converter.

15-51

BUILDING NO. 40	HARDWARE																				SOFTWARE																												
SYSTEM(S) SINGLE ZONE DX AHU	OUTPUT								INPUT												ALARMS							APPLICATION PROGRAMS																					
OCCUPANCY TIME	DIGITAL					ANALOG			DIGITAL							ANALOG					DIGITAL			ANALOG																									
GRAPHIC DISPLAY ● / POINT DESCRIPTION	CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO		CONTROL POINT ADJUSTMENT	MOTOR ACTUATOR	PID CONTROLLER	PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE			TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW	CONTACT CLOSURE			HIGH LIMIT	LOW LIMIT	RUN TIME		SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL				FAILURE MODE **
SINGLE ZONE DX AHU																																																	
SUPPLY FAN	●									●											●					●		●	●	●	●	●																		O
RETURN FAN										●											●																													
O. A. DAMPER				●			■	■											■													●	●	■																N
MIXED AIR																●								●	●																									
SUPPLY AIR																●								●	●																									
RETURN AIR																●	●							●	●																									
SPACE																●	●							●	●				●	●		●																		
FILTER										●											●																													
OUTSIDE AIR *																●	●																																	

* ONE MEASUREMENT FOR ENTIRE SYSTEM
** C - LAST COMMAND   O - ON (OPEN)
H - HIGH VALUE   F - OFF (CLOSED)
L - LOW VALUE   N - LOCAL LOOP

Table 4-5. I/O summary table for single zone DX-AC unit.

15-52

BUILDING NO's 40 & 44	HARDWARE																			
	OUTPUT								INPUT											
	DIGITAL					ANALOG			DIGITAL							ANALOG				
SYSTEM(S) SINGLE ZONE AHU																				
OCCUPANCY TIME																				
GRAPHIC DISPLAY ●																				
POINT DESCRIPTION	CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO		CONTROL POINT ADJUSTMENT	MOTOR ACTUATOR	PID CONTROLLER	PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE			TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW
SINGLE ZONE AHU																				
SUPPLY FAN	●									●										
RETURN FAN										●										
O. A. DAMPER				●			■	■											■	
MIXED AIR																●				
SUPPLY AIR																●				
RETURN AIR																●	●			
SPACE																●	●			
FILTER										●										
OUTSIDE AIR *																●	●			

	SOFTWARE																												
	ALARMS							APPLICATION PROGRAMS																					
	DIGITAL			ANALOG																									
POINT DESCRIPTION	CONTACT CLOSURE			HIGH LIMIT	LOW LIMIT	RUN TIME		SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL				FAILURE MODE **
SINGLE ZONE AHU																													
SUPPLY FAN	●					●		●	●	●	●	●																	O
RETURN FAN	●																												
O. A. DAMPER												●	●	■															N
MIXED AIR				●	●																								
SUPPLY AIR				●	●																								
RETURN AIR				●	●																								
SPACE				●	●				●	●		●																	
FILTER	●																												
OUTSIDE AIR *																													

* ONE MEASUREMENT FOR ENTIRE SYSTEM
** C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Table 4-1. I/O summary table for single zone AHU.

15-53

BUILDING NO. 44

SYSTEM(S)

HEATING AAND VENTILATING UNIT

OCCUPANCY TIME

GRAPHIC DISPLAY ●

	HARDWARE OUTPUT DIGITAL				HARDWARE OUTPUT ANALOG			HARDWARE INPUT DIGITAL					HARDWARE INPUT ANALOG					SOFTWARE ALARMS DIGITAL	SOFTWARE ALARMS ANALOG			SOFTWARE APPLICATION PROGRAMS																		
POINT DESCRIPTION	CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO	CONTROL POINT ADJUSTMENT	MOTOR ACTUATOR	PID CONTROLLER	PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE	TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW	CONTACT CLOSURE	HIGH LIMIT	LOW LIMIT	RUN TIME	SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL	FAILURE MODE * *
H & V UNIT																																								
SUPPLY FAN	●								●									●			●	●	●	●	●	●	●	●												O
RETURN FAN									●									●																						
O. A. DAMPER				●		■	■									■										●		■												N
MIXED AIR													●						●	●																				
SUPPLY AIR													●						●	●																				
SPACE													●						●	●			●	●		●														
FILTER									●									●																						
[OUT]SIDE AIR *													●																											

* ONE MEASUREMENT FOR ENTIRE SYSTEM
* * C - LAST COMMAND O - ON (OPEN)
H - HIGH VALUE F - OFF (CLOSED)
L - LOW VALUE N - LOCAL LOOP

Table 4-9. I/O summary table for heating and ventilating unit.

15-54

BUILDING NO. 120

SYSTEM(S) [redacted] MULTI-ZONE AHU

OCCUPANCY TIME

GRAPHIC DISPLAY ●

POINT DESCRIPTION	HARDWARE OUTPUT DIGITAL: CONTROL RELAY	SOLENOID	HAND/OFF/AUTO	OFF/AUTO	HARDWARE OUTPUT ANALOG: CONTROL POINT ADJUSTMENT	MOTOR ACTUATOR	PID CONTROLLER	HARDWARE INPUT DIGITAL: PRESSURE SWITCH	DIFFERENTIAL PRESSURE SWITCH	FLOW SWITCH	AUXILIARY CONTACT	PULSE	HARDWARE INPUT ANALOG: TEMPERATURE (DEGREES F)	% RELATIVE HUMIDITY	PSIG, PSIA, PSID	POSITION	FLOW
TERMINAL REHEAT AHU																	
SUPPLY FAN	●								●								
RETURN FAN									●								
O. A. DAMPER				●		■	■									■	
MIXED AIR													●				
SUPPLY AIR					●								●				
RETURN AIR													●	●			
SPACE													●	●			
REHEAT VALVE																●	
FILTER									●								
OUTSIDE AIR *													■	●			

POINT DESCRIPTION	SOFTWARE ALARMS DIGITAL: CONTACT CLOSURE	SOFTWARE ALARMS ANALOG: HIGH LIMIT	LOW LIMIT	RUN TIME	APPLICATION PROGRAMS: SCHEDULED START/STOP	OPTIMUM START/STOP	DUTY CYCLING	DEMAND LIMITING	DAY/NIGHT SETBACK	ECONOMIZER	VENTILATION/RECIRCULATION	HOT/COLD DECK RESET	REHEAT COIL RESET	STEAM BOILER SELECTION	HOT WATER BOILER SELECTION	HW OA RESET	CHILLER SELECTION	CHILLED WATER RESET	CONDENSER WATER RESET	CHILLER DEMAND LIMIT	LIGHTING CONTROL	REMOTE BOILER MONITORING CONTROL	FAILURE MODE * *
TERMINAL REHEAT AHU																							
SUPPLY FAN	●			●	●	●	●	●	●														O
RETURN FAN	●																						
O. A. DAMPER									●	●	■												N
MIXED AIR		●	●																				
SUPPLY AIR		●	●										●										L
RETURN AIR		●	●																				
SPACE		●	●			●	●		●														
REHEAT VALVE													●										
FILTER	●																						
OUTSIDE AIR *																							

* ONE MEASUREMENT FOR ENTIRE SYSTEM

* * C - LAST COMMAND   O - ON (OPEN)
H - HIGH VALUE   F - OFF (CLOSED)
L - LOW VALUE   N - LOCAL LOOP

Table 4-2. I/O summary table for [redacted] multi-zone *AHU.*

15 · 55

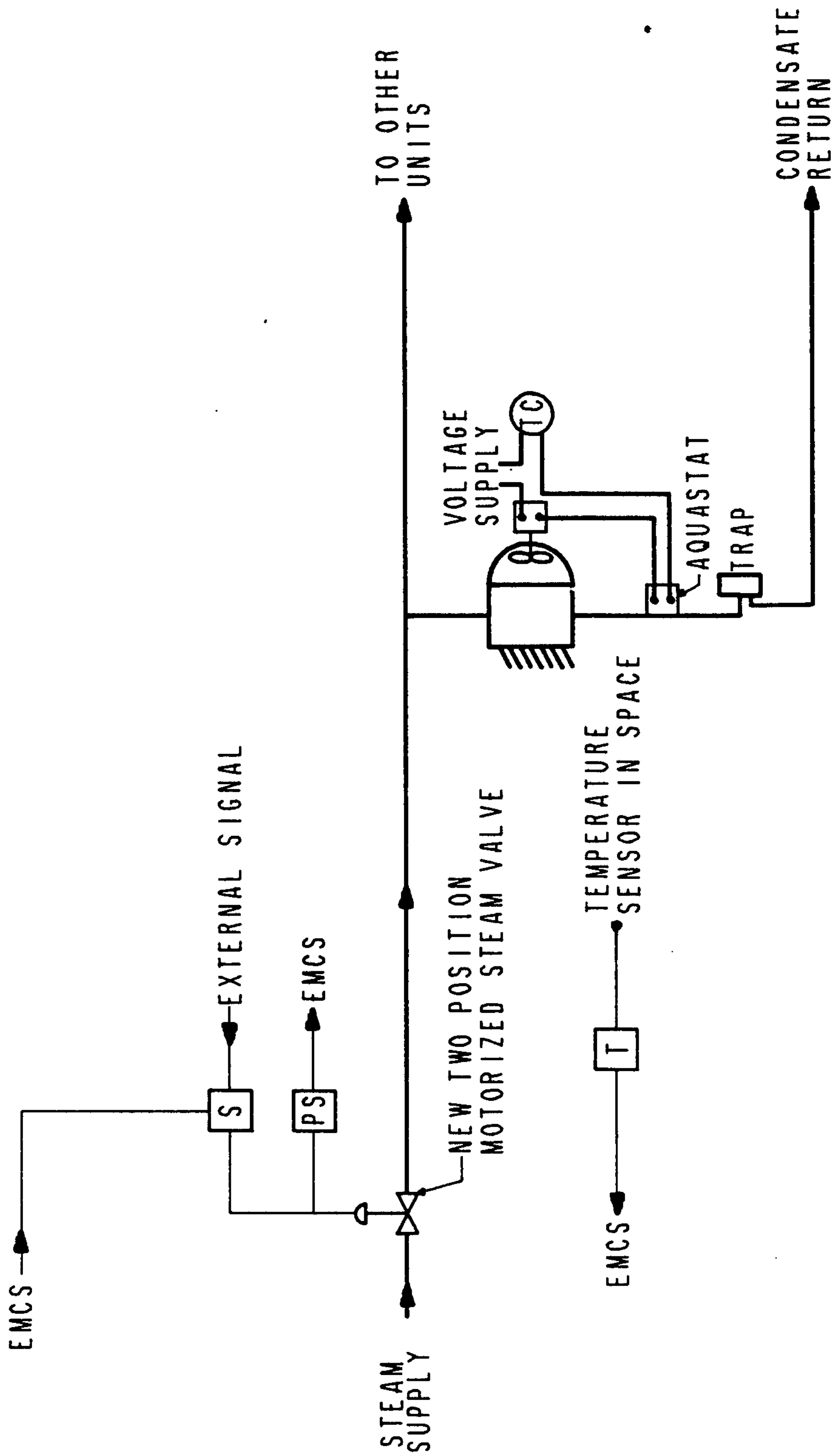


Figure 4-10. Steam unit heater schematic.

15-56

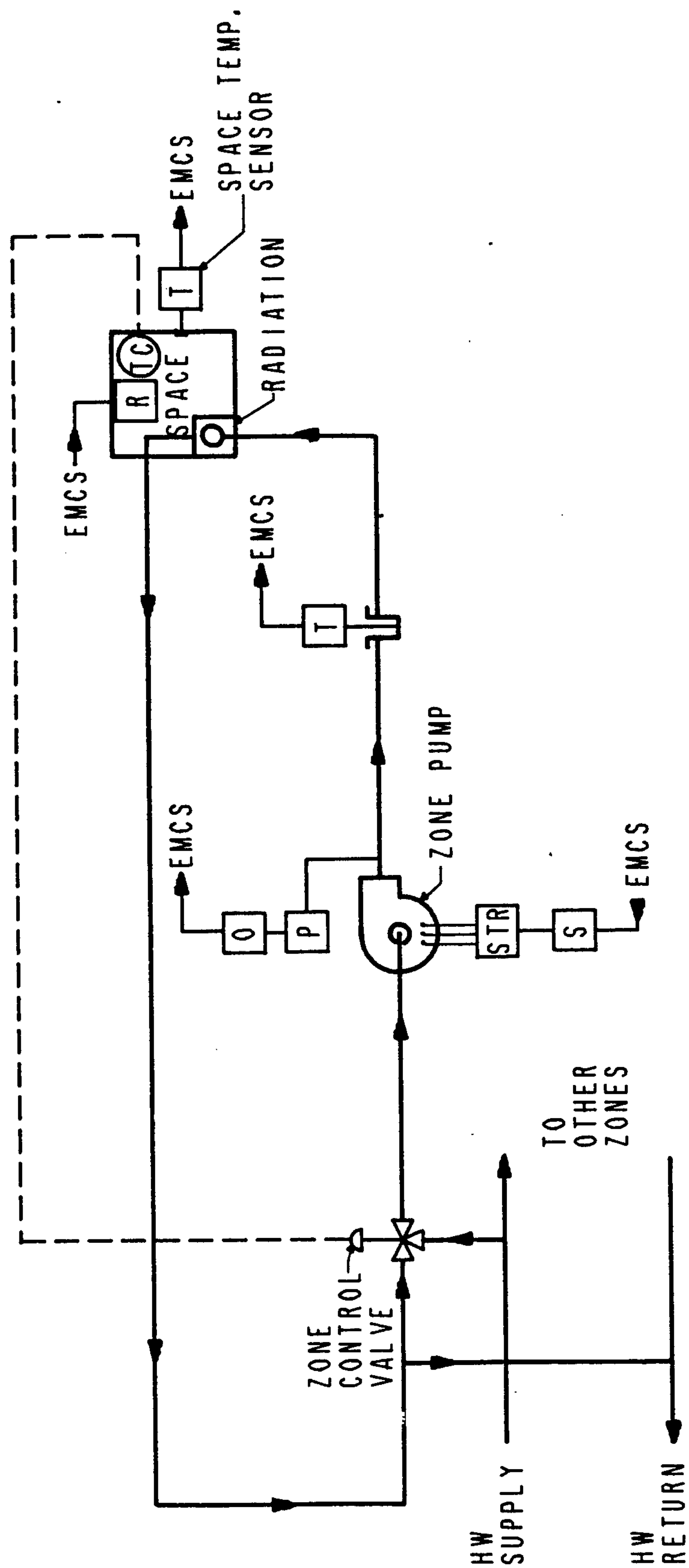


Figure 4-15. Hot water radiation schematic.

15-57

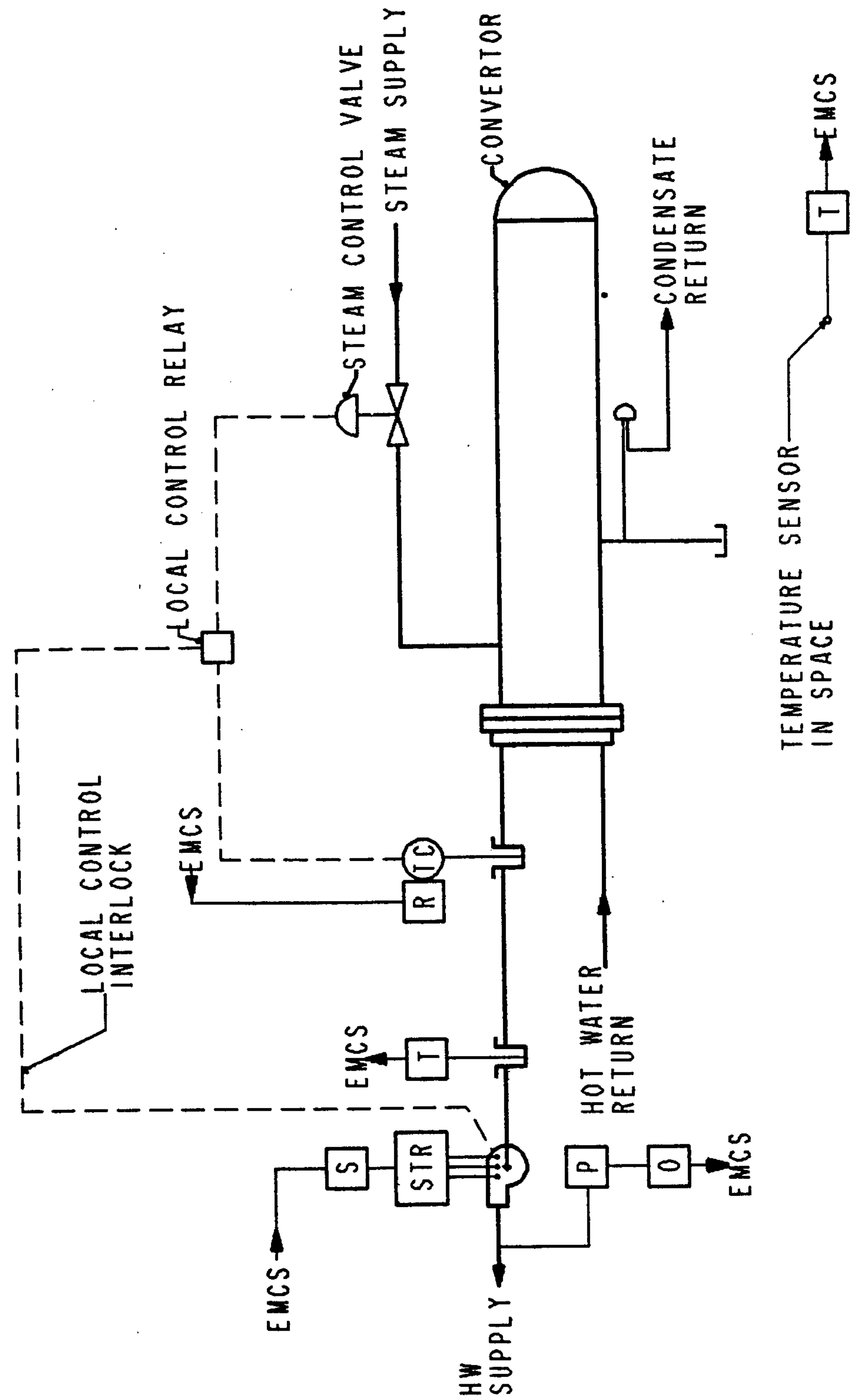


Figure 4-20. Steam/HW converter schematic.

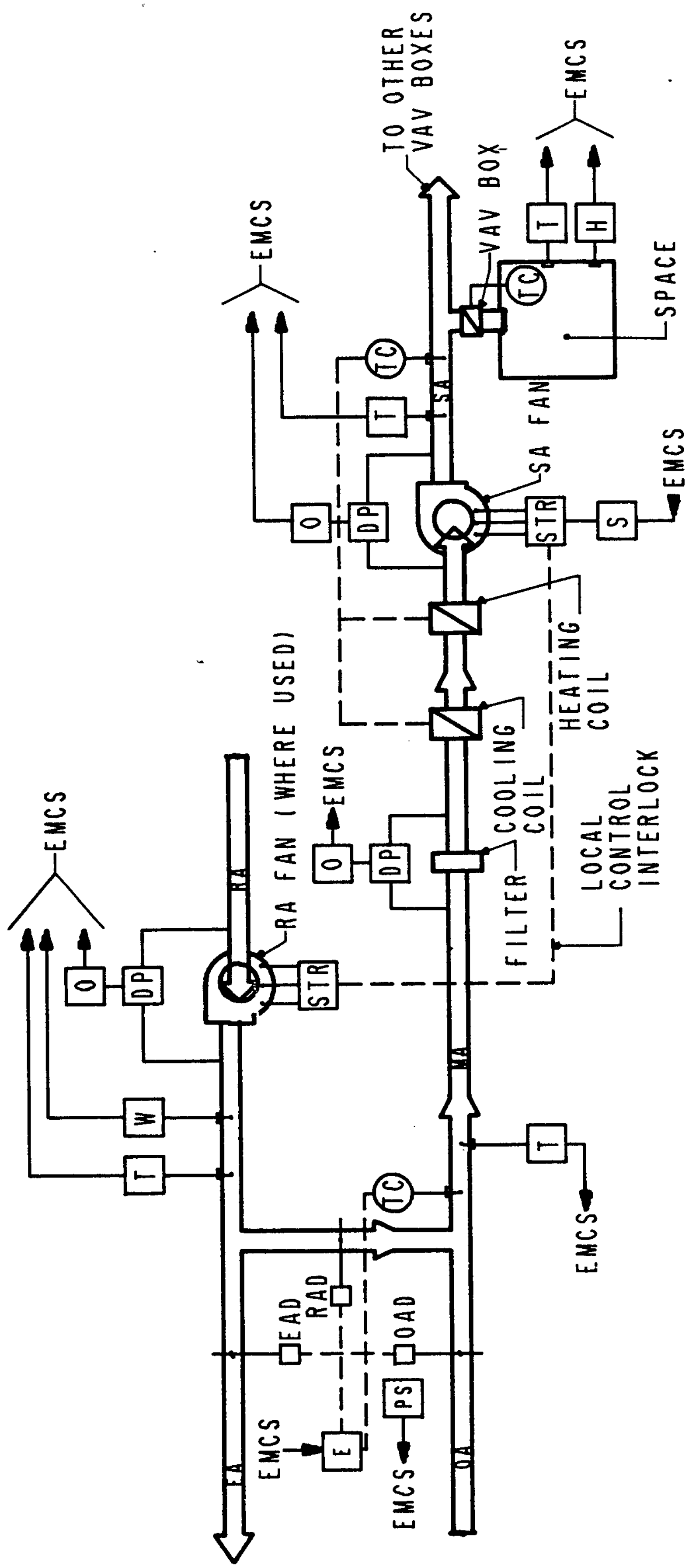


Figure 4-3. Variable air volume AHU schematic.

15-59

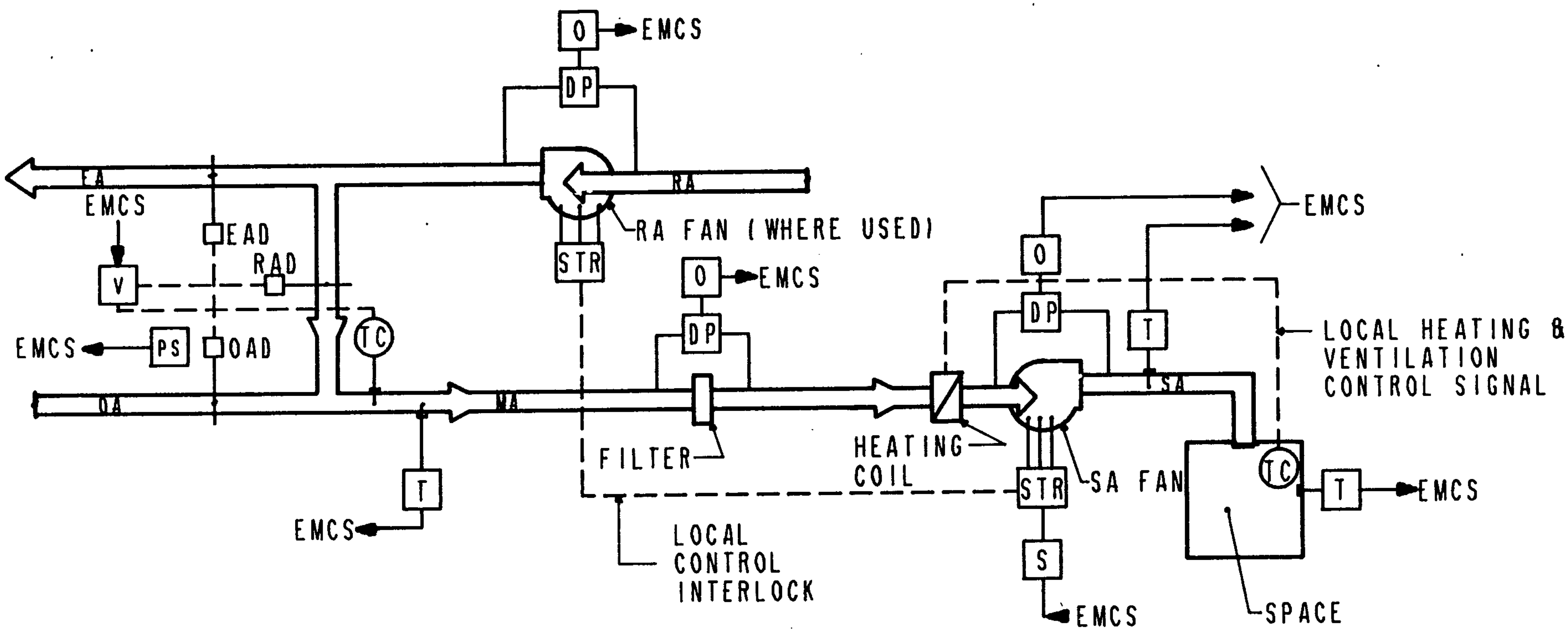


Figure 4-9. Heating and ventilating unit schematic.

15-60

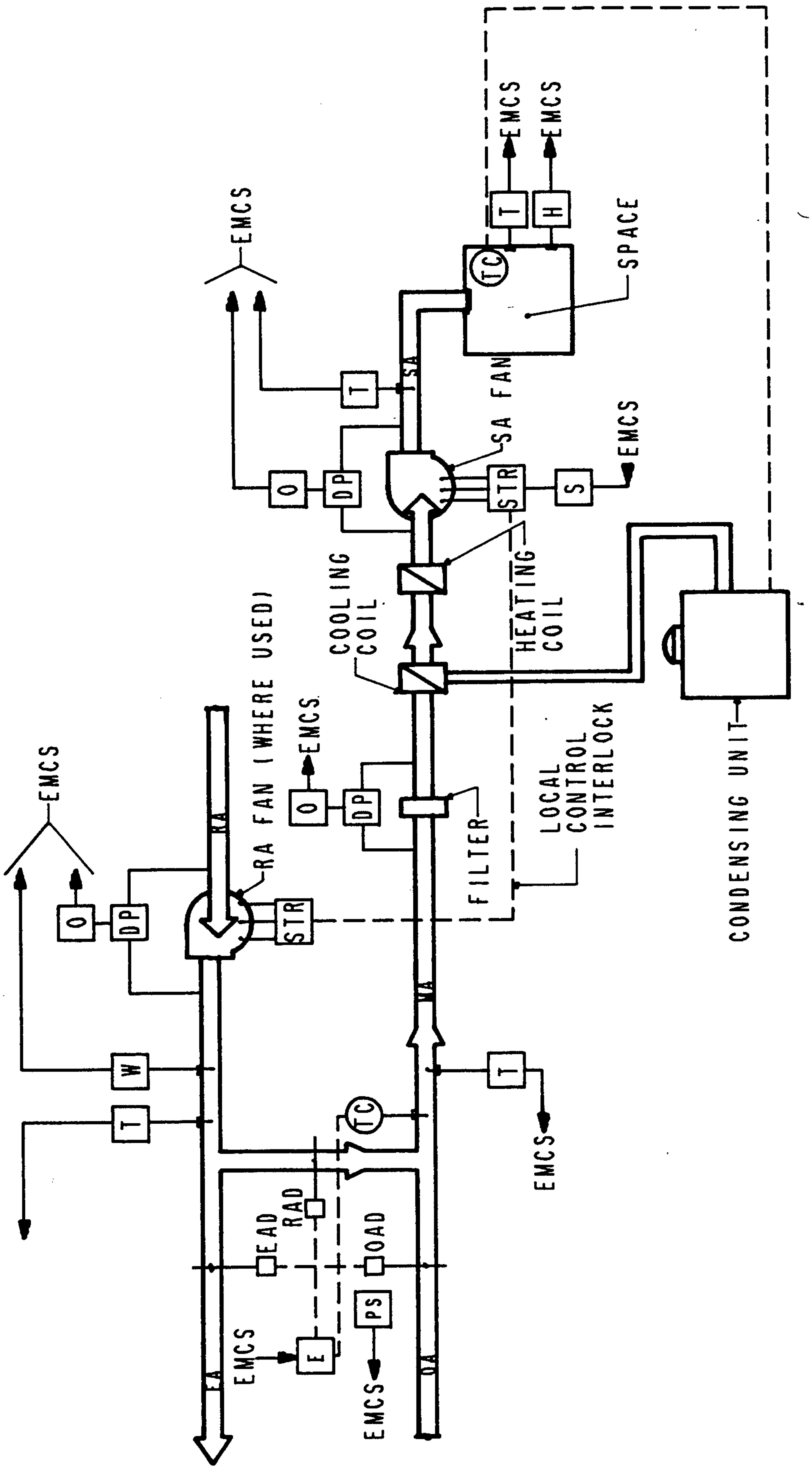


Figure 4-5. Single zone DX-AC unit schematic.

15-61

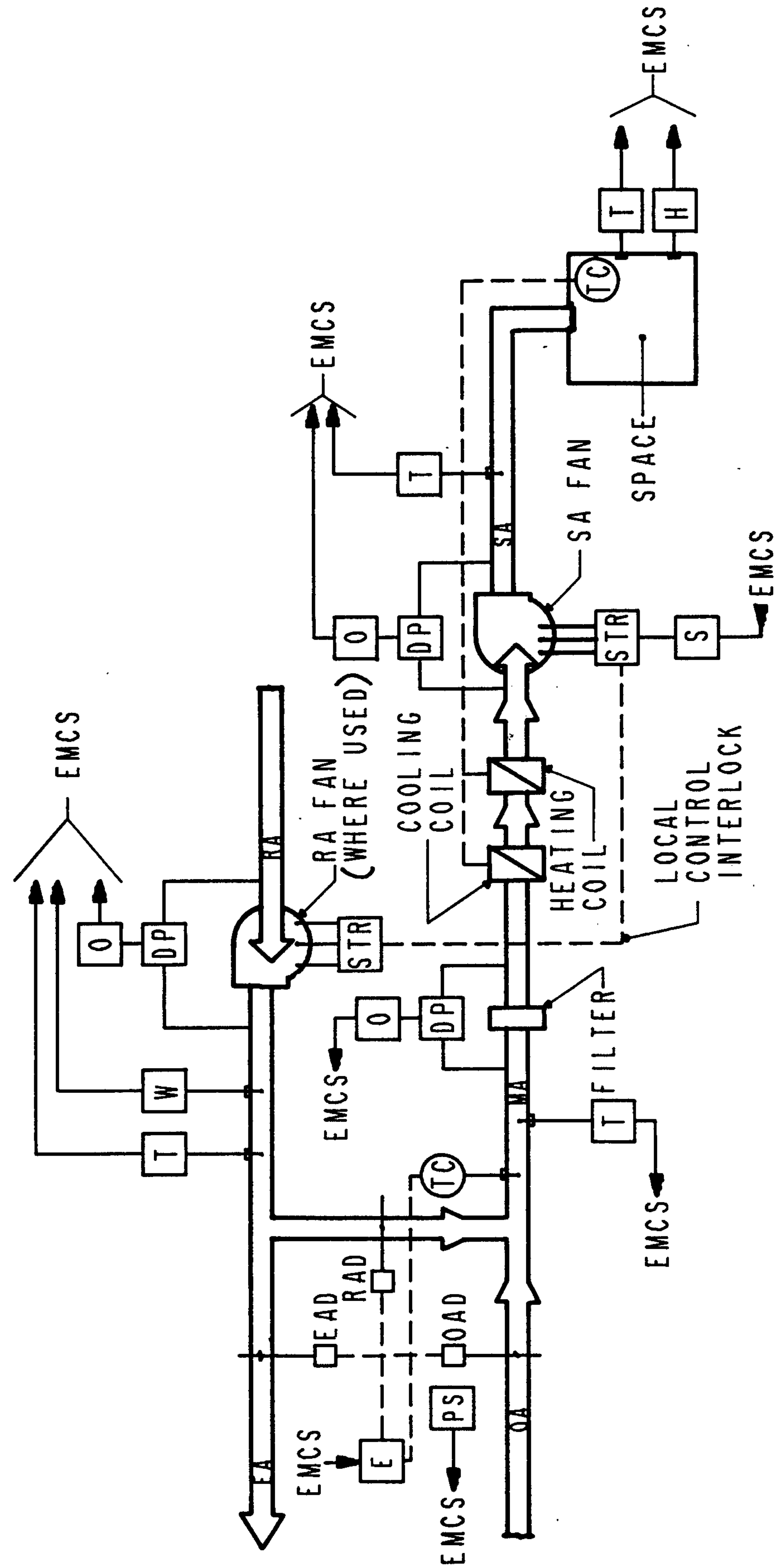


Figure 4-1. Single zone AHU schematic.

15-62

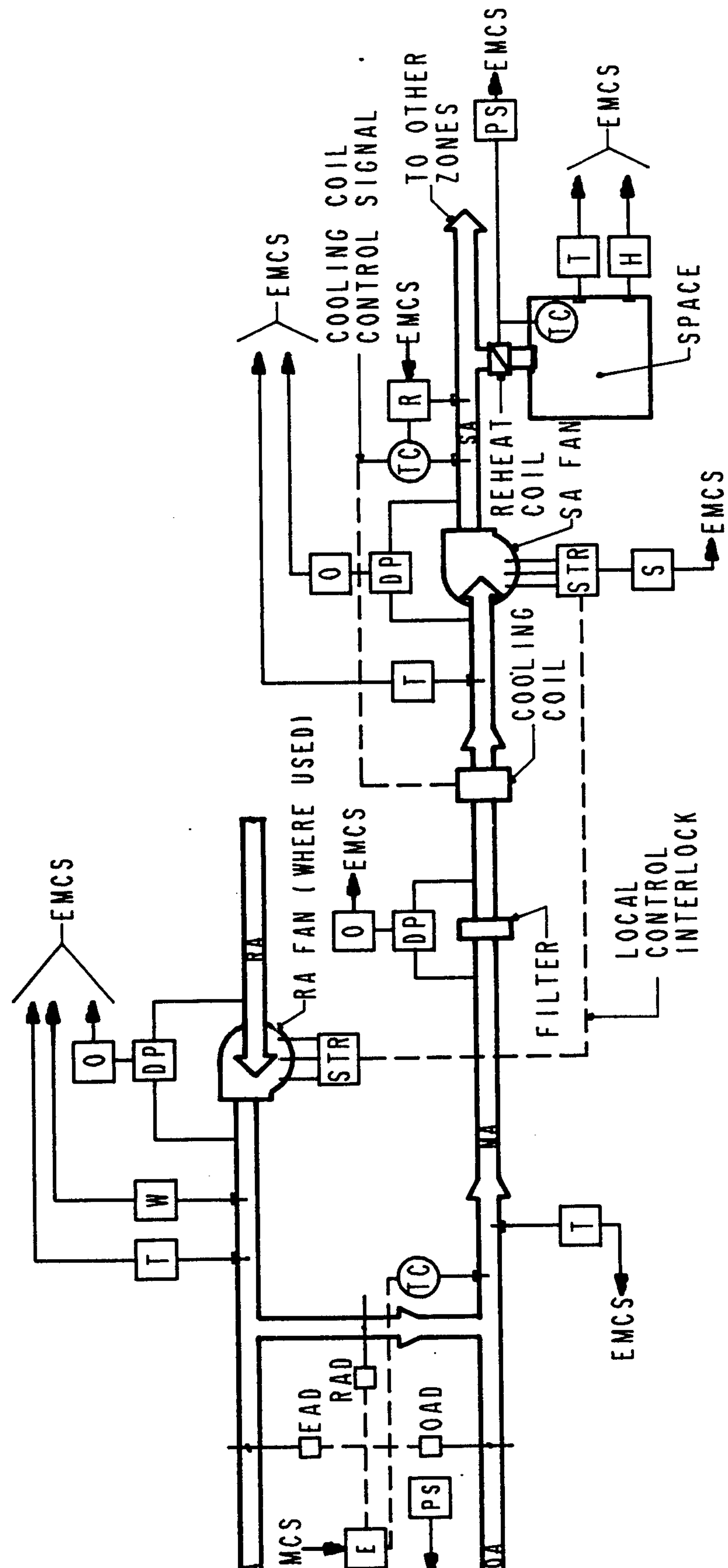


Figure 4-2. Terminal reheat AHU schematic.

15-63

Symbol	Description
→ EMCS	SIGNAL TRANSMITTED TO EMCS
← EMCS	SIGNAL TRANSMITTED FROM EMCS
A	ALARM CONTACT SIGNAL
E	ECONOMIZER CONTROL INTERFACE
F	FLOW INDICATION
FL	FLAME INDICATION
H	HUMIDITY INDICATION
P	PRESSURE INDICATION
LV	LEVEL INDICATION
M	METER
O	ON-OFF STATUS SIGNAL
DP	DIFFERENTIAL PRESSURE SWITCH
R	CONTROLLER RESET INTERFACE
S	START-STOP INTERFACE
T	TEMPERATURE INDICATION
V	VENTILATION/RECIRCULATION CONTROL
PS	POSITION
O_2	FLUE GAS ANALYSIS, OXYGEN
CO	FLUE GAS ANALYSIS, CARBON MONOXIDE

Symbol	Description
FD	FURNACE DRAFT DIFFERENTIAL PRESSURE
DS	HIGH-LOW DEMAND SIGNAL SELECTOR
TC	TEMPERATURE CONTROLLER
PC	PRESSURE CONTROLLER
STR	MOTOR STARTER
	SENSOR INSTALLED IN THERMOMETER WELL
	SENSOR INSTALLED IN DUCT OR PLENUM
CHW	CHILLED WATER
EA	EXHAUST AIR
SA	SUPPLY AIR
RA	RETURN AIR
OA	OUTSIDE AIR
MA	MIXED AIR
WB	WET BULB
DB	DRY BULB
OAD	OUTSIDE AIR DAMPER
RAD	RETURN AIR DAMPER
EAD	EXHAUST AIR DAMPER
MZD	MULTIZONE DAMPER
RH	RELATIVE HUMIDITY

Table 4-30. Symbols and abbreviations.

15-64

WATERVLIET ARSENAL MANUAL STEAM VALVE LOG

PROD — PROD — PROD — OPNS — PROP. DISP. — STOREHOUSE — PROD — DALLIBA HALL — FAC.'S — PROD. — FIRE STAT. — CAFE. — MOTOR POOL — BENET — BENET

	BLDG	#	135B	135T	110	20	24	116	145	121	123	126	130	125	~~44~~ 1W	~~44~~ 1E	132	120	25	114	124	22	21	17	15	405	~~35~~ 40NW	
	DATE	TIME									N																	
	10/9	0500					N								N	N		N			N				N	N	N	
T	10/8	1415		F		F	F		F					F	F	F		F	F						F-	F	F	
W	10-9	1610		F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	
R	10-10	0501		F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	
F	10/11	0630		N	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N		N	N	N	N	N	
	10/11	0930		F	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	TEMP 52°
	10/11	2010		N		N																						
M	10/14	1610		F		F																						
Ø	10/14	2200							N								N											
	10/14	2300		N	N	N												N	N									
T	10/15	0500					N		N	N		N		N	N	N				N	N		N	N	N	N	N	
	10/15	1430			F		F		F	F			F		F	F		F		F	F		F	F	F	F	F	60°
	~~10/15~~	~~[illegible]~~ DCB											~~N~~ DCB															
	10/15	1620		F		F						F	F	F			F		F									
W	10-16	0545					N		N						N	N			N					N	N	N	N	
	10/16	0745		N	N	N		N		N		N	N	N				N		N	N		N					
	10/16	1630		F	F	F	F	F	F	F			F	F	F	F	F	F	F	F	F		F	F	F			
R	10-17	0400		N		N	N												N									
	10-17	0415			N			N	N	N			N	N	N	N	N	N		N	N		N	N	N			
	10-17	0600		F																								
	10-17	1600			F	F	F	F	F	F			F	F	F	F	F	F	F	F	F		F	F	F		F	
F	10-18	0530			N	N	N	N	N	N			N	N	N	N	N	N	N	N	N		N	N	N			
	10/18	0900		~~F~~ DCB	F	F	F	F	F	F		F	F	F	F	F	F	F	F	F	F		F	F	F	F	F	60°

N = ON
F = OFF

15-65

15-66

PC Magazine Feb. 25, 1992

RS&H

Telephone Call Confirmation

Project No. 290-0379-002

Local ____ L.D. ✓ Placed ✓ Rec'd. ____ Date 2/11/92

P. Hutchins Conversed With Frank Carlen

Of Huntsville Div. COE Regarding EMCS

Mr. Deshazo will send me info. on latest guidelines

He also said the ETL not allowing IDC has been rescinded as of last week.

Mr. Deshazo

FID drives 16 MUX's

MUX can drive 64 pts.

MUX's can be located 100 yds away from FID w/o special driver - even further with modem

Distribution:

15-67

RS&H

Telephone Call Confirmation

Project No. 290-0379-002

Local ____ L.D. ____ Placed ____ Rec'd. ____ Date 3-2-92

B. Todd Conversed With Jim Kief (or Edward Maruszcak)

Of WVA - Communications Regarding EMCS.

(518) 266-5312

WVA uses "twisted pairs" for their control wiring.

Control wiring for Don Brooks' "EMCS" consists of 50 twisted pairs, and they are centrally wired through Building 112 (mid-Building 110)

They currently do not have enough extra wires to each Building for an EMCS.

Distribution:

15-68

RS&H

Telephone Call Confirmation

Project No. 290-0379-002

Local ______ L.D. ______ Placed ______ Rec'd. ______ Date 3-3-92

B. Todd Conversed With Mr. Deshazo

Of Army COE, Huntsville Div. Regarding EMCS Configuration

(205) 895-3324

Our cost for the medium EMCS is over $400,000.

That seems high for just 134 points.

Suggests we use a 16 bit or 32 bit IBM Compatable PC with 1 MB of RAM, an internal clock, floppy disk drive, hard disk drive, a dial-up modem and a CRT (monitor).

A printer is also required for data and alarm printouts.

They have used a PC with 64 KB RAM to drive an EMCS with 1000 points.

Distribution:

RS&H®

SUBJECT WVA - Building 44
Add Return Air to HV-1

DESIGNER W. T. Todd

CHECKER

AEP NO 290-0379-002

SHEET 1 OF

DATE 2-13-92

.DATE

ECO # 16

Reduce Outside Air / Add Return Air to HV-1

Heating and Ventilating unit HV-1 was designed to heat 100% outside air for ventiation of the basement. HV-1 operates 24 hours per day.

The current winter operating mode of HV-1 returns approximately 30% of the supply air through transfer grilles and an opening in the mechanical equipment room door. This mode of operation saves some heating energy but causes a large negative pressure on the basement area which increases the infiltration of outside air.

In 1981, Planning Research Corporation submitted a project to reduce the outside air intake of HV-1 by adding a return air system and controlling the exhaust fans. This analysis is an update of the project submitted by Planning Research Corporation.

The existing and proposed new ventilation modes, and the proposed operating schedule are shown in the tables on the following page.

Current Energy Use:

The basement is maintained at 68°, 24 hours per day, 7 days per week. The heating energy required to heat the outside air was calculated using a

BASEMENT/HV-1 AIR FLOWS (CFM)

Fan No. & Location		Existing Modes -- MER Damper -- Open	Closed	New Ventilation Modes Min	Med	Max
E1	East	0	4850	0	0	4850
E2	East	2430	2430	0	0	2430
E3 or E6	East	1200	1200	1200	1200	1200
E13	East	4850	4850	0	4850	4850
E15	East	2430	2430	0	0	2430
E18	East	200	200	200	200	200
E7 or E5	Center	7520	11280	3760	7520	11280
E16	Storage	827	827	827	827	827
E4	West	9820	9820	0	0	9820
Total Exhaust Air		29277	37887	5987	14597	37887
HV-1 Outside Air		24073	34390	5800	14272	34390
HV-1 Return Air		10317		28590	20118	0
HV-1 Supply Air		34390	34390	34390	34390	34390
Net Air Flow		-5204	-3497	-187	-325	-3497

HV-1 PROPOSED VENTILATION SCHEDULE

Daily Shift Hours	Vent. Mode	Hours of Operation Mon	Tue	Wed	Thu	Fri	Sat	Sun
12M-8AM	Min	7	7	7	7	7	8	8
	Med	1	1	1	1	1	0	0
	Max	0	0	0	0	0	0	0
8AM-4PM	Min	0	0	0	0	0	8	8
	Med	6	6	6	6	6	0	0
	Max	2	2	2	2	2	0	0
4PM-12M	Min	0	0	0	0	0	8	8
	Med	8	8	8	8	8	0	0
	Max	0	0	0	0	0	0	0

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SUBJECT WVA - Bldg. 44 Add Return Air — AEP NO 290-0379-002

DESIGNER W. T. Todd — SHEET 3 OF

CHECKER — DATE 2-13-92

DATE

computer spreadsheet program. This program uses bin temperature data for Albany, NY and the following equation:

$$Q = O.A.\ cfm \times 1.1 \times \Delta T \times hrs/yr$$

The results (see printout on page 6) show that the energy required to heat outside air for HV-1 is:

$$Q_c = 4972.3\ MBtu/yr$$

Assuming a boiler efficiency of 0.80 and a steam to hot water converter efficiency of 0.95:

$$Q_c\ (F.O.\ \#6) = 4972.3 \frac{MBtu}{yr} \div 0.8 \div 0.95 = \underline{6542.5 \frac{MBtu}{yr}}$$

The fan for HV-1 will be adjusted to overcome the additional friction of the new return air system. The increased electricity use by this fan motor is expected to be offset by the reduced operating hours of the various exhaust fans.

Future Energy Use:

Saving will be achieved reducing the amount of outside air to be heated and also by reducing the temperature during the third shift and during weekends.

The same computer spreadsheet program was used

to calculate the future energy use in the various ventilation modes.

The results (see printouts on pages 7 - 10) are shown below:

* Min. Vent. w/ setback to 55°F :

$$3\text{rd shift} : Q_3 = 172.3\ \text{mBtu}/\text{yr}$$

$$\text{Weekends} : Q_w = 194.4\ \text{mBtu}/\text{yr}$$

* Medium vent. mode, 68 °F, shifts 1 & 2 :

$$Q_m = 1228.2\ \text{mBtu}/\text{yr}$$

* Maximum vent. mode, 68°F, 2 hours during 1st shift:

$$Q_{mx} = 349.1\ \text{mBtu}/\text{yr}$$

The total heating energy required is:

$$Q_F = Q_{mx} + Q_m + Q_w + Q_3$$

$$Q_F = (349.1 + 1228.2 + 194.4 + 172.3)\ \text{mBtu}/\text{yr}$$

$$Q_F = 1944.0\ \text{mBtu}/\text{yr}$$

Applying the boiler and converter efficiencies:

$$Q_F\,(\text{F.O.\#6}) = 1944.0\ \frac{\text{mBtu}}{\text{yr}} \div 0.8 \div 0.95 = \underline{2557.9\ \text{mBtu}/\text{yr}}$$

SUBJECT ECO # 16

AEP NO

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QRIP Calculations

Present Method

#6 F.O. = 6543 $\frac{\text{MBtu}}{\text{yr}}$ * $\frac{\$4.40}{\text{MBTU}}$ = $28,300

Proposed Method

#6 F.O. = 2558 $\frac{\text{MBtu}}{\text{yr}}$ * $\frac{\$4.40}{\text{MBtu}}$ = $11,300

Savings = $17,500

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SUBJECT	WVA - Bldg. 44 Add Return Air	AEP NO	290-0379-002
		SHEET	5 OF
DESIGNER	W. T. Todd	DATE	2-13-92
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Fuel Oil #6 Savings:

Energy Savings = Current Energy Use - Future Energy Use

$$\text{Savings} = Q_c - Q_F = 6542.5\ \frac{\text{MBtu}}{\text{yr}} - 2557.9\ \frac{\text{MBtu}}{\text{yr}}$$

Energy Savings = **3984.6 MBtu/yr**

Project Implementation Cost:

The original costs were estimated in 1980 dollars. The ENR Building Cost Index (BCI) is used to escalate the cost estimate to August 1991 dollars.

June 1980 ENR BCI = 1916
August 1991 ENR BCI = 2792

Escalation Factor = 2792/1916 = 1.46

1991 Bare costs: Labor(1): \$13549 × 1.46 = \$19,782
Mater.(1): \$14313 × 1.46 = \$20,897

(1) Source: Planning Research Corp. Cost Estimate, p. 16-21

Total Project Cost = \$70,259

See cost estimate sheets for details

HV-1, Current operating mode

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 02/12/92

INPUTS:
1) Days Per Week That HVAC Operates — 7 Days/Week
2) Summer Room Dry Bulb Temperature — °F (db)
   Room Wet Bulb Temperature — °F (wb)
3) Winter Room Dry Bulb Temperature — 68 °F (db)
   If RH Controlled, wb Temp. — °F (wb)
   and Ground Water Temperature — °F
4) Outside Air Quantity (cfm) — 24073 cfm
5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM — 8 Hrs/Shift
   8 AM -> 4 PM — 8 Hrs/Shift
   4 PM -> 12 M — 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	7	0.00	0.00	0.00	0.00
90	94	72	0	28	6	34	0.00	0.00	0.00	0.00
85	89	71	0	95	28	123	0.00	0.00	0.00	0.00
80	84	68	4	177	73	254	0.00	0.00	0.00	0.00
75	79	66	27	248	140	415	0.00	0.00	0.00	0.00
70	74	64	115	257	222	594	0.00	0.00	0.00	0.00
65	69	61	234	235	271	740	0.00	0.00	0.00	0.00
60	64	57	263	212	252	727	0.00	0.00	115.51	0.00
55	59	52	274	190	236	700	0.00	0.00	203.90	0.00
50	54	48	263	183	214	660	0.00	0.00	279.63	0.00
45	49	43	242	183	205	630	0.00	0.00	350.33	0.00
40	44	38	229	202	205	636	0.00	0.00	437.88	0.00
35	39	34	261	241	251	753	0.00	0.00	618.13	0.00
30	34	30	295	220	262	777	0.00	0.00	740.71	0.00
25	29	25	216	156	191	563	0.00	0.00	611.24	0.00
20	24	20	163	112	130	405	0.00	0.00	493.33	0.00
15	19	16	110	79	96	285	0.00	0.00	384.89	0.00
10	14	11	84	43	65	192	0.00	0.00	284.72	0.00
5	9	6	60	27	38	125	0.00	0.00	201.91	0.00
0	4	2	37	16	22	75	0.00	0.00	131.08	0.00
-5	-1	-3	27	3	9	39	0.00	0.00	73.32	0.00
-10	-6	-8	10	0	4	14	0.00	0.00	28.18	0.00
-15	-11	-13	5	0	0	5	0.00	0.00	10.72	0.00
-20	-16	-17	3	0	0	3	0.00	0.00	6.83	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	8756	0.00	0.00	4972.31	0.00
Total operating hours for each system							0	0	6589	0

HV-1, Minimum ventilation mode with setback

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 02/12/92

INPUTS:
1) Days Per Week That HVAC Operates — 5 Days/Week
2) Summer Room Dry Bulb Temperature — °F (db)
   Room Wet Bulb Temperature — °F (wb)
3) Winter Room Dry Bulb Temperature — 55 °F (db)
   If RH Controlled, wb Temp. — °F (wb)
   and Ground Water Temperature — °F
4) Outside Air Quantity (cfm) — 5800 cfm
5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM — 7 Hrs/Shift
   8 AM -> 4 PM — 0 Hrs/Shift
   4 PM -> 12 M — 0 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	0	0.00	0.00	0.00	0.00
90	94	72	0	28	6	0	0.00	0.00	0.00	0.00
85	89	71	0	95	28	0	0.00	0.00	0.00	0.00
80	84	68	4	177	73	3	0.00	0.00	0.00	0.00
75	79	66	27	248	140	17	0.00	0.00	0.00	0.00
70	74	64	115	257	222	72	0.00	0.00	0.00	0.00
65	69	61	234	235	271	146	0.00	0.00	0.00	0.00
60	64	57	263	212	252	164	0.00	0.00	0.00	0.00
55	59	52	274	190	236	171	0.00	0.00	0.00	0.00
50	54	48	263	183	214	164	0.00	0.00	0.00	0.00
45	49	43	242	183	205	151	0.00	0.00	7.72	0.00
40	44	38	229	202	205	143	0.00	0.00	11.87	0.00
35	39	34	261	241	251	163	0.00	0.00	18.73	0.00
30	34	30	295	220	262	184	0.00	0.00	27.06	0.00
25	29	25	216	156	191	135	0.00	0.00	24.12	0.00
20	24	20	163	112	130	102	0.00	0.00	21.45	0.00
15	19	16	110	79	96	69	0.00	0.00	16.67	0.00
10	14	11	84	43	65	53	0.00	0.00	14.40	0.00
5	9	6	60	27	38	38	0.00	0.00	11.48	0.00
0	4	2	37	16	22	23	0.00	0.00	7.82	0.00
-5	-1	-3	27	3	9	17	0.00	0.00	6.24	0.00
-10	-6	-8	10	0	4	6	0.00	0.00	2.51	0.00
-15	-11	-13	5	0	0	3	0.00	0.00	1.36	0.00
-20	-16	-17	3	0	0	2	0.00	0.00	0.87	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	1826	0.00	0.00	172.30	0.00
Total operating hours for each system							0	0	1089	0

HV-1, Medium ventilation mode

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 02/12/92

INPUTS:
1) Days Per Week That HVAC Operates — 5 Days/Week
2) Summer Room Dry Bulb Temperature — °F (db)
   Room Wet Bulb Temperature — °F (wb)
3) Winter Room Dry Bulb Temperature — 68 °F (db)
   If RH Controlled, wb Temp. — °F (wb)
   and Ground Water Temperature — °F
4) Outside Air Quantity (cfm) — 14272 cfm
5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM — 1 Hrs/Shift
   8 AM -> 4 PM — 6 Hrs/Shift
   4 PM -> 12 M — 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	4	0.00	0.00	0.00	0.00
90	94	72	0	28	6	19	0.00	0.00	0.00	0.00
85	89	71	0	95	28	71	0.00	0.00	0.00	0.00
80	84	68	4	177	73	147	0.00	0.00	0.00	0.00
75	79	66	27	248	140	235	0.00	0.00	0.00	0.00
70	74	64	115	257	222	307	0.00	0.00	0.00	0.00
65	69	61	234	235	271	340	0.00	0.00	0.00	0.00
60	64	57	263	212	252	317	0.00	0.00	29.86	0.00
55	59	52	274	190	236	295	0.00	0.00	50.91	0.00
50	54	48	263	183	214	274	0.00	0.00	68.92	0.00
45	49	43	242	183	205	266	0.00	0.00	87.72	0.00
40	44	38	229	202	205	275	0.00	0.00	112.29	0.00
35	39	34	261	241	251	332	0.00	0.00	161.43	0.00
30	34	30	295	220	262	331	0.00	0.00	187.26	0.00
25	29	25	216	156	191	239	0.00	0.00	154.02	0.00
20	24	20	163	112	130	167	0.00	0.00	120.90	0.00
15	19	16	110	79	96	121	0.00	0.00	96.65	0.00
10	14	11	84	43	65	77	0.00	0.00	67.66	0.00
5	9	6	60	27	38	47	0.00	0.00	44.98	0.00
0	4	2	37	16	22	28	0.00	0.00	28.59	0.00
-5	-1	-3	27	3	9	10	0.00	0.00	11.64	0.00
-10	-6	-8	10	0	4	4	0.00	0.00	4.47	0.00
-15	-11	-13	5	0	0	0	0.00	0.00	0.57	0.00
-20	-16	-17	3	0	0	0	0.00	0.00	0.36	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	3908	0.00	0.00	1228.24	0.00
Total operating hours for each system							0	0	2784	0

HV-1, Maximum ventilation mode

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 02/12/92

INPUTS:
1) Days Per Week That HVAC Operates 5 Days/Week
2) Summer Room Dry Bulb Temperature °F (db)
Room Wet Bulb Temperature °F (wb)
3) Winter Room Dry Bulb Temperature 68 °F (db)
If RH Controlled, wb Temp. °F (wb)
and Ground Water Temperature °F
4) Outside Air Quantity (cfm) 34390 cfm
5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM 0 Hrs/Shift
8 AM -> 4 PM 2 Hrs/Shift
4 PM -> 12 M 0 Hrs/Shift

Temperatures			Hours of Occurrence			Total	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24	Oper. Hours	Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	1	0.00	0.00	0.00	0.00
90	94	72	0	28	6	5	0.00	0.00	0.00	0.00
85	89	71	0	95	28	17	0.00	0.00	0.00	0.00
80	84	68	4	177	73	32	0.00	0.00	0.00	0.00
75	79	66	27	248	140	44	0.00	0.00	0.00	0.00
70	74	64	115	257	222	46	0.00	0.00	0.00	0.00
65	69	61	234	235	271	42	0.00	0.00	0.00	0.00
60	64	57	263	212	252	38	0.00	0.00	8.59	0.00
55	59	52	274	190	236	34	0.00	0.00	14.12	0.00
50	54	48	263	183	214	33	0.00	0.00	19.78	0.00
45	49	43	242	183	205	33	0.00	0.00	25.96	0.00
40	44	38	229	202	205	36	0.00	0.00	35.48	0.00
35	39	34	261	241	251	43	0.00	0.00	50.47	0.00
30	34	30	295	220	262	39	0.00	0.00	53.50	0.00
25	29	25	216	156	191	28	0.00	0.00	43.21	0.00
20	24	20	163	112	130	20	0.00	0.00	34.80	0.00
15	19	16	110	79	96	14	0.00	0.00	27.22	0.00
10	14	11	84	43	65	8	0.00	0.00	16.27	0.00
5	9	6	60	27	38	5	0.00	0.00	11.13	0.00
0	4	2	37	16	22	3	0.00	0.00	7.13	0.00
-5	-1	-3	27	3	9	1	0.00	0.00	1.44	0.00
-10	-6	-8	10	0	4	0	0.00	0.00	0.00	0.00
-15	-11	-13	5	0	0	0	0.00	0.00	0.00	0.00
-20	-16	-17	3	0	0	0	0.00	0.00	0.00	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	520	0.00	0.00	349.09	0.00
Total operating hours for each system							0	0	333	0

HV-1, minimum ventilation mode with setback

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 02/12/92

INPUTS:
1) Days Per Week That HVAC Operates 2 Days/Week
2) Summer Room Dry Bulb Temperature °F (db)
   Room Wet Bulb Temperature °F (wb)
3) Winter Room Dry Bulb Temperature 55 °F (db)
   If RH Controlled, wb Temp. °F (wb)
   and Ground Water Temperature °F
4) Outside Air Quantity (cfm) 5800 cfm
5) HVAC Oper. Hrs/Shft: 12 M -> 8 AM 8 Hrs/Shift
   8 AM -> 4 PM 8 Hrs/Shift
   4 PM -> 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper. Hours	Outside Air Load (MBtu/Yr)			
db-Range		wb	00-08	08-16	16-24		Cooling	Dehumid	Heating	Humid.
120	124					0	0.00	0.00	0.00	0.00
115	119					0	0.00	0.00	0.00	0.00
110	114					0	0.00	0.00	0.00	0.00
105	109					0	0.00	0.00	0.00	0.00
100	104					0	0.00	0.00	0.00	0.00
95	99	75	0	7	0	2	0.00	0.00	0.00	0.00
90	94	72	0	28	6	10	0.00	0.00	0.00	0.00
85	89	71	0	95	28	35	0.00	0.00	0.00	0.00
80	84	68	4	177	73	73	0.00	0.00	0.00	0.00
75	79	66	27	248	140	119	0.00	0.00	0.00	0.00
70	74	64	115	257	222	170	0.00	0.00	0.00	0.00
65	69	61	234	235	271	211	0.00	0.00	0.00	0.00
60	64	57	263	212	252	208	0.00	0.00	0.00	0.00
55	59	52	274	190	236	200	0.00	0.00	0.00	0.00
50	54	48	263	183	214	189	0.00	0.00	0.00	0.00
45	49	43	242	183	205	180	0.00	0.00	9.19	0.00
40	44	38	229	202	205	182	0.00	0.00	15.07	0.00
35	39	34	261	241	251	215	0.00	0.00	24.71	0.00
30	34	30	295	220	262	222	0.00	0.00	32.58	0.00
25	29	25	216	156	191	161	0.00	0.00	28.74	0.00
20	24	20	163	112	130	116	0.00	0.00	24.36	0.00
15	19	16	110	79	96	81	0.00	0.00	19.74	0.00
10	14	11	84	43	65	55	0.00	0.00	15.05	0.00
5	9	6	60	27	38	36	0.00	0.00	10.94	0.00
0	4	2	37	16	22	21	0.00	0.00	7.25	0.00
-5	-1	-3	27	3	9	11	0.00	0.00	4.12	0.00
-10	-6	-8	10	0	4	4	0.00	0.00	1.61	0.00
-15	-11	-13	5	0	0	1	0.00	0.00	0.62	0.00
-20	-16	-17	3	0	0	1	0.00	0.00	0.40	0.00
-25	-21					0	0.00	0.00	0.00	0.00
-30	-26					0	0.00	0.00	0.00	0.00
-35	-31					0	0.00	0.00	0.00	0.00
-40	-36					0	0.00	0.00	0.00	0.00
-45	-41					0	0.00	0.00	0.00	0.00
Totals			2922	2914	2920	2502	0.00	0.00	194.36	0.00

Total operating hours for each system 0 0 1286 0

02/13/92

ECO Construction Cost Estimate
Calculations

ECO Name: Reduce Outside Air and Add Return Air to HV-1

ECO #: ~~TBD~~ 16

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$20,897
Labor		$19,782
	Subtotal bare costs	$40,679
FICA Insurance (20% of Labor)		$3,956
Sales Tax (Not Applicable For GOGO)		$0
	Subtotal	$44,635
Overhead (15%)		$6,695
	Subtotal	$51,330
Profit (10%)		$5,133
	Subtotal	$56,463
Bond (1%)		$565
	Subtotal	$57,028
Contingency (10%)		$5,703
Subtotal (Construction Cost Input For LCCID *)		$62,731
SIOH (6.0% of Construction Cost)		$3,764
	Subtotal	$66,495
Design (6.0% of Construction Cost)		$3,764
Total Project Cost		$70,259

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

From Planning Research Corp. 1981 Energy Study of WVA

11.1.2.2 Reduce Outside Air Intake.

11.1.2.2.1 Background. The ventilation system in the basement of building 44 is designed for 100 percent outside air (34,390 cfm) with no provisions for modulation or use of return air when maximum ventilation rate is not required. This results in heating an excessive amount of outside air during the heating season. Energy savings will result if a return air system is installed. Outside air and exhaust can be minimized and modulated incrementally to increase when additional ventilation is required. Return air would be modulated in inverse proportion to the outside air volume. In addition, room temperature could be set back during unoccupied hours.

11.1.2.2.2 Modification Recommended at Building 44. Modification of the outside air plenum for HV-1 will be required to make provisions for the addition of a return air plenum, and return air/outside air motorized mixing dampers. Two new return air ducts will be routed to the return air plenum. Belt and pulley replacements will be required to adjust the fan speed for HV-1 to maintain flow volume at increased pressure drop in the return air system. Refer to figure 11-3 for a sketch depicting the changes. Replacement of fan E12 with a two-speed fan and the elimination of the transfer grill through the inside wall is recommended. Mechanical equipment rooms will be ventilated with a maximum of outside air from the existing motorized damper in the outside wall of the air handler room or a minimum of outside air from the new damper in the outside wall of the heating equipment room. A new thermostat in the air handler room will control dampers and fan speed.

Medium Ventilation Mode. Exhaust fan controls will be modified to interlock the most strategic fans with HV-1 for normal daily operations. The recommended fans are E3/E6, E13, E18, E7/E5, and E16. Outside air and return air dampers will automatically be positioned to proportion the air volumes noted as the recommended medium ventilation mode in table 11-3.

Maximum Vent Mode. If additional ventilation is required, when operating in the medium ventilation mode, an adjustable timed switch (2 hours maximum) will be provided to start each of the other fans E1, E2, E15 and E4 individually. In

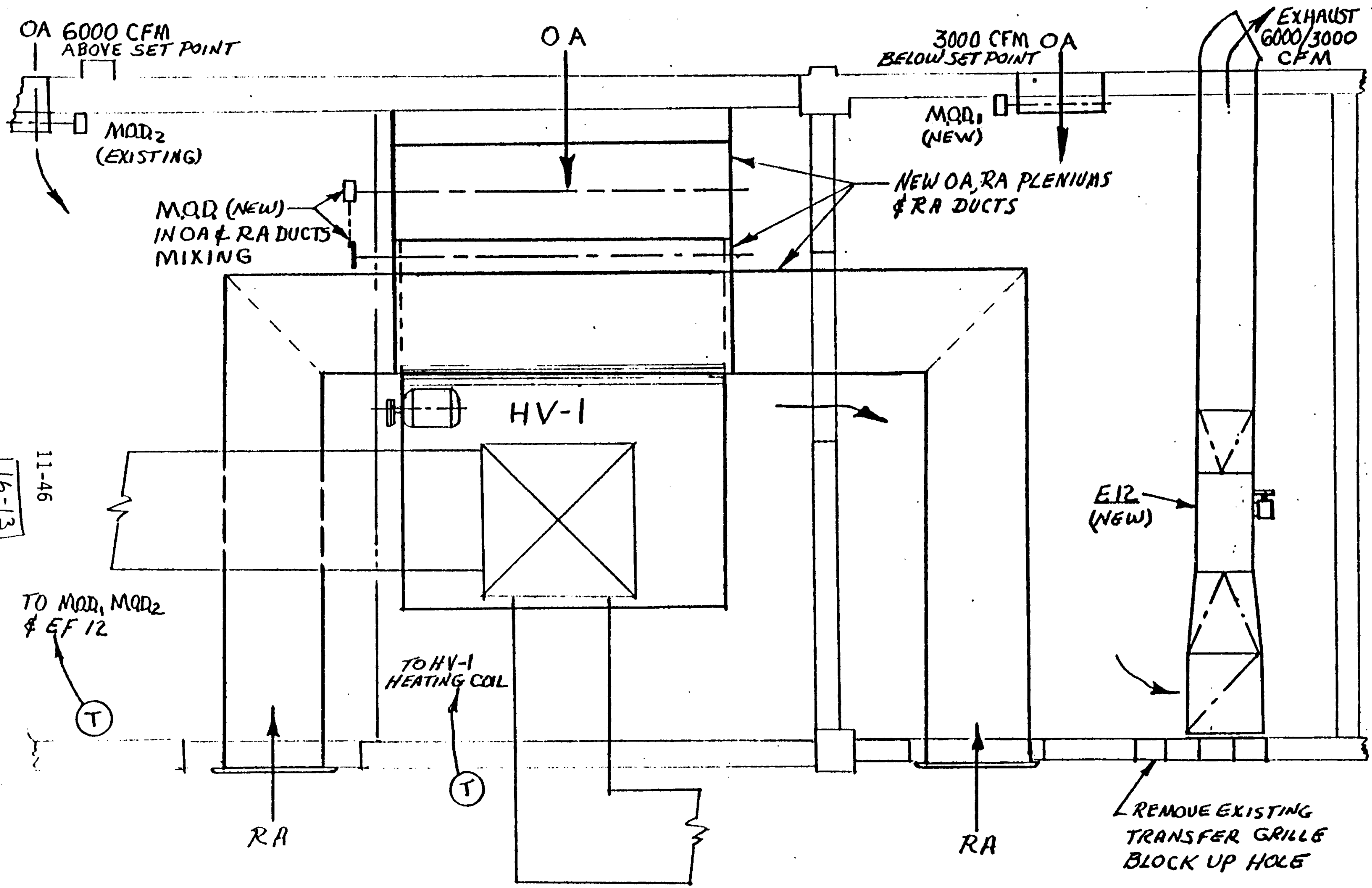

FIGURE 11-3
MECHANICAL EQUIPMENT ROOM CHANGES

Table 11-3. Exhaust cfm from Basement

Fan No./Location		Design Mode		Recommended Ventilation Modes		
		MER Damper Pos. OPEN (winter)	MER Damper Pos. CLOSED (Summer)	Minimum	Medium	Maximum
E1	East	0	4850	0	0	4850
E2	East	2430	2430	0	0	2430
E3 or E6	East	1200	1200	1200/0	1200/0	1200/0
E13	East	4850	4850	0	4850	4850
E15	East	2430	2430	0	0	2430
~~E8~~ E18	East	200	200	200	200	200
E7 or E5	Center	~~3760~~/7520	3760/7520	3760/0*	~~3760/0*~~ 7520	3760/7520*
E12	MER	~~6000~~	0	0**	0**	0**
E16	Secure Storage	827	827	827	827	827
E4	West	9820	9820	0	0	9820
Total Exhaust		39037	37887	5987	~~10837~~ 14597	37887
O/A		34390 ×0.7	34390	5800	~~10512~~ 14272	34390
Return		~~0~~ 34390 x 0.3	0	~~28950~~ 28590	~~23878~~ 20118	0
Supply		34390	34390	34390	34390	34390
Excess Exhaust		~~-4647~~ -5204	-3497	-187	-325	-3497

this area has a separate O.A. intake

* Either fan E5 or E7 can be selected to operate at slow speed, the other fan will stop in the minimum or medium mode; in the maximum mode one fan can operate fast while the other operates slow.

** E12 does not exhaust air from basement rooms with recommended ventilation modes. Existing MER damper is removed and hole is used for return air duct or is blocked.

addition, a remote switch located near each fan can initiate a maximum of 2-hour runtime. Return and outside air dampers will modulate to admit more outside air and less return air incrementally as each fan is started.

<u>Minimum Vent Mode (Setback)</u>. During nonoccupied hours, minimum exhaust is required, in addition, lower room temperature can be used during the heating season. Fans not required will be shut down during unoccupied hours then restarted prior to occupancy. Return and outisde air would be modulated accordingly. This can be accomplished by the Energy Monitor and Control System if incorporated at Watervliet. For the purpose of economic analysis, costs include a timeclock system to reduce ventilation rate and a setback thermostat for room temperature reduction.

11.1.2.2.3 Analysis/Justification. Heat is provided to the coil in HV-1 during October through April (30 weeks). Energy and dollar savings will result from heating a reduced amount of cold outside air during a majority of the occupied hours. Additional savings will accrue during unoccupied hours when the outside air is further reduced and the room is maintained at a lower temperature. Heating degree hours have been used as noted in table 11-4 with the following basic equation to estimate energy use.

Btu = cfm x 1.1 x Degree Hours

<u>Existing System Operation</u>. Basement room temperature is maintained at 65° to 69°F. HV-1 was observed to operate with the outside air duct partially closed and the plenum access door partially open. Basement room air returns through the 48- by 24-inch transfer grill in the heating equipment room wall to HV-1. Outside air volume was estimated at 70 percent and return air at 30 percent of the supply air.

Energy required = 34,390 x .7 x 1.1 x 152,102 = 4,027.707 MBtu/yr @ HV-1

Table 11-4. Heating Degree Hours
(Based on Albany Weather Data)

	Ref Temp = 65°			Ref Temp = 50°		
	01 - 08	09 - 16	17 - 24	01 - 08	09-16	17 - 24
Oct	4,884	2,212	3,521	1,657	320	837
Nov	6,872	5,113	6,150	3,394	1,899	2,735
Dec	10,157	8,746	9,338	6,442	5,072	5,672
Jan	11,158	9,711	10,346	7,448	6,017	6,643
Feb	9,844	8,104	8,898	6,501	4,772	5,512
Mar	9,049	6,920	7,834	5,342	3,347	4,163
Apr	5,744	3,242	4,223	2,359	790	1,347
Totals	57,708	44,084	50,310	33,143	22,217	26,909
Grand Totals		152,102			82,269	

Recommended System Operation. After modifications to provide for outside/return air modulation during the medium, maximum, and minimum ventilation modes and to provide for temperature reduction during unoccupied hours, energy consumption will be reduced. The following operating schedule is recommended.

Operation During 30-Week Heating Season: The room is maintained at 65° 1 hour prior to and during occupied hours. This would occur during the last hour of the third shift, during the 8-hour dayshift for 5 days per week plus one Saturday per month, and during one second shift per month. It is estimated the medium ventilation mode will be used for 70 percent and the maximum ventilation mode will be used 30 percent of the occupied hours. During unoccupied hours, the room is maintained at 50° and the minimum ventilation rate is used, except the room temperature is increased to 65° 1 hour prior to occupancy.

Operation During the 22-Week Summer Season: Significant energy savings are not anticipated since all fans will probably be required to provide ventilation and temperature control.

Operating Hours (30 Week Heating Season):

Room at 65° — 3rd Shift; 1 Hr, 5 Shift/Wk + 1 Hr, 1 Sat/Mo
Day Shift; 8 Hr, 5 Day/Wk + 8 Hr, 1 Sat/Mo
2nd Shift; 8 Hr/Mo

$$\% \text{ 3rd Shift Hrs} = \frac{1 \times 5 \times 30 + 1 \times 1 \times 1/4 \times 30}{8 \times 7 \times 30} \times 100 = 9.375\%$$

$$\% \text{ Day Shift Hrs} = \frac{8 \times 5 \times 30 + 8 \times 1/4 \times 30}{8 \times 7 \times 30} \times 100 = 75\%$$

$$\% \text{ 2nd Shift Hrs} = \frac{8 \times 1/4 \times 30}{8 \times 7 \times 30} \times 100 = 3.57\%$$

Room at 50°

% 3rd Shift Hrs = 100 - 9.375 = 90.625%

% Day Shift Hrs = 100 - 75 = 25%

% 2nd Shift Hrs = 100 - 3.57 = 96.25%

Heat Required for Outside Air (Recommended System):

3rd Shift

Room 65°, med vent:	10,512 x 1.1 x 57,708 x .09375	= 62.558
Room 50°, min vent:	5,800 x 1.1 x 33,143 x .90625	= 191.629

Day Shift

Room 65°, med vent:	10,512 x 1.1 x 44,084 x .75 x .70	= 267.620
Room 65°, max vent:	34,390 x 1.1 x 44,084 x .75 x .30	= 375.222
Room 50°, min vent:	5,800 x 1.1 x 22,217 x .25	= 35.436

2nd Shift

Room 65°, med vent: 10,512 x 1.1 x 50,310 x .0357 x .70 = 14.538

Room 65°, max vent: 34,390 x 1.1 x 50,310 x .0357 x .30 = 20.383

Room 50°, min vent: 5,800 x 1.1 x 26,909 x .9625 = 165.241

TOTAL 1,132.627 MBtu/yr

Savings With Reduced Outside Air and Temperature Set Back:

Heat Required (Existing) - Heat Required (Recommended) = Savings

Heat Saved @ HV-1 = 4,027.707 - 1,132.627 = 2,895.08 MBtu/yr

$$\text{Heat Saved @ Boiler} = \frac{2{,}895.08}{.7} = 4{,}135.83 \text{ MBtu/yr}$$

$$\text{Gallons No. 6 Oil} = \frac{4{,}125.16 \times 10^6}{149{,}690} = 27{,}629 \text{ Gal/yr}$$

Maintenance and Operating Costs

Materials	
Replacement Parts and Expendables	500
Labor	
Periodic Checks and Replacements	1,200
	$1,700

11.1.2.2.4 ECIP Summary - Building 44 Outside Air Reduction. See ECIP and cost sheets for details; benefits are summarized as follows:

Energy Savings	4,135.83 MBtu/yr
Dollar Savings	$31,926/yr
Project Cost	$82,766
B/C	9.5
E/C	49.97
EC/CC	10.2
Payback	2.6 years

ECIP Economic Analysis Summary

Location: Watervliet Arsenal, Building 44, Basement FY 84
Project : Reduce Exhaust and Outside Air

Economic Life: 25 Yrs. Date Prepared: 8/19/81 Prepared by W.J. Spillman

COSTS

1. Non-recurring Initial Capital Costs:

a. CWE	$	82,766
b. Design $.06 \times 51,553 \times (1.12)^{2.75}$	$	4,224
c.	$	0
d. Total		$ 86,990

BENEFITS

2. Recurring Benefit/Cost Differential Other Than Energy:

a. Annual Labor Decrease (+)/Increase (-)	$	-1,200/Yr.
b. Annual Material Decrease (+)/Increase (-)	$	-500/Yr.
c. Other Annual Decrease (+)/Increase (-)	$	0 /Yr.
d. Total Costs	$	-1,700/Yr.
e. 10% Discount Factor	$	9.524
f. Discounted Recurring Cost (d x e)		$ -16,191

3. Recurring Energy Benefit/Costs:

a. Type of Fuel: No. 6 Fuel Oil		
(1) Annual Energy Decrease (+)/Increase (-)		4,136 MBTU
(2) Cost per MBTU (October 1, 1984)	$	8.13/MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$	33,626/Yr.
(4) Differential Escalation Rate (10%) Factor		25
(5) Discounted Dollar Decrease/Increase (3)x(4)	$	840,650
b. Type of Fuel:		
(1) Annual Energy Decrease (+)/Increase (-)		MBTU
(2) Cost per MBTU	$	/MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$	/Yr.
(4) Differential Escalation Rate (___) Factor		
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$	
c. Type of Fuel:		
(1) Annual Energy Decrease (+)/Increase (-)		MBTU
(2) Cost per MBTU	$	/MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$	/Yr.
(4) Differential Escalation Rate (__%) Factor		
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$	
d. Type of Fuel:		
(1) Annual Energy Decrease (+)/Increase (-)		MBTU
(2) Cost per MBTU	$	/MBTU
(3) Annual Dollar Decrease/Increase ((1)x(2))	$	/Yr.
(4) Differential Escalation Rate (__%) Factor		
(5) Discounted Dollar Decrease/Increase ((3)x(4))	$	
e. Discounted Energy Benefits (3a(5)+3b(5)+3c(5)+3d(5))		$ 840,642

4. Total Benefits (Sum 2f+3e)	$	824,459
5. Discounted Benefit/Cost Ratio (Line 4 ÷ Line 1d)		9.5
6. Total Annual Energy Savings (3a(1)+3b(1)+3c(1)+3d(1))		4,136
7. E/C Ratio (Line 6 ÷ Line 1a/1000)		49.97
8. Annual $ Savings (2d+3a(3)+3b(3)+3c(3)+3d(3))	$	31,926
9. Pay-back Period ((Line 1a - Salvage) ÷ Line 8)		2.6
10. EC/CC = [Line 3a(3) + 3b(3)] x 25 ÷ Line 1a		10.2

CONSTRUCTION COST ESTIMATE	DATE PREPARED 8/5/81	SHEET 1 OF 3

PROJECT: REDUCE EXHAUST & OUTSIDE AIR

LOCATION: WATERVLIET BUILDING 44 BASEMENT

ARCHITECT ENGINEER: PLANNING RESEARCH CORP.

BASIS FOR ESTIMATE
- [X] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO.	COST AS OF (DATE)	ESTIMATOR	CHECKED BY
	1/1/80	W. J. Spillman	

1980 Means SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Subtotals from Sht. 2 and 3							
Mechanical				10660		9681	
Electrical				2454		4347	
General				435		285	
Subtotals				13549		14313	
Joint Occupancy-Overtime	Labor X	30%		4065		-	
Subtotals				17614		14313	
12%/yr in FL	1	ea	12%	2114		1718	
				19728		16031	
SUB-TOTAL				19728		16031	33759
SALES TAX					0 %	-	
SUB-TOTAL				19728		16031	
PT&I			22 %	4340			
SUB-TOTAL				24068		16031	
OVERHEAD & PROFIT			22 %	5295	22 %	3527	
SUB-TOTAL				29363		19558	
GEOGRAPHIC			-7 %	2055	- %	-	
SUB-TOTAL				27308		19558	= 46866
CONTINGENCY	10 %						4687
CONSTRUCTION COST							51553
SIOH	5 %						2578
PROJECT COST (Jan 1981)							54131
ESCALATION	52.9 %						28635
PROJECT COST (Oct 1981)							82766

ENG FORM 150 1 AUG 59 @ 14.23; 17614 ÷ 14.23 = 1238 MH

PREVIOUS EDITION MAY BE USED

11-53

16-21

CONSTRUCTION COST ESTIMATE

DATE PREPARED 8/5/81 | SHEET 2 OF 3

PROJECT: REDUCE EXHAUST AND OUTSIDE AIR

LOCATION: WATERVLIET BUILDING 44 BASEMENT

ARCHITECT ENGINEER: PLANNING RESEARCH CORP

BASIS FOR ESTIMATE:
- ☒ CODE A (NO DESIGN COMPLETED) XX
- ☐ CODE B (PRELIMINARY DESIGN)
- ☐ CODE C (FINAL DESIGN)
- ☐ OTHER (SPECIFY)

DRAWING NO.: | COST AS OF (DATE): 1/1/80 | ESTIMATOR: W. J. Spillman | CHECKED BY:

1980 Means (REFERENCES)	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST	REFER. PAGE
(Mechanical)								
Ductwork- R/A	2220	LB	1.25	2775	.45	999		159
R/A & O/A Plenum	975	LB	1.25	1219	.45	439		159
Damper Motors	3	EA	35	105	198	594		Honeywel
Damper Linkage	3	EA	35	105	50	150		Honeywel
Damper - RA	1	EA	140	140	632	632		Honeywel
Damper - OA	1	EA	140	140	632	632		Honeywel
Dampers - Vent Air	1	EA	70	70	408	408		Honeywel
Ductwork - Vent Air	700	Lb.	1.25	875	.45	315		159
Exhaust Fan - Vent Air	1	EA	90	90	1450	1450		163
T-Stat-Ef/Dampers	1	EA	36	36	34	34		Honeywel
T-Stat (Set Back)	1	EA	36	36	114	114		Honeywel
Insulation 1 1/2 in.	1400	SF	1.57	2198	.98	1372		135
Belts (HV-1)	2	EA	9	18	6	12		Grange
Pulleys	2	EA	18	32	54	108		Grange
Masonry Removal	5	EA	70	350	10	50		WJS
Masonry Restoration	5	EA	140	700	50	250		WJS
Pipe & Equip.Relocation	1	Job	500	500	500	500		WJS
Heating Coil Controls	1	EA	250	250	1150	1150		151
Paint	500	SF	.23	115	.06	30		164
RA Registers	2	EA	21	42	71	142		156
Test and Balance	12	EA	72	864	25	300		148
Subtotal				10660		9681		
(General)								
MOB/DEMOB	1	Job	300	300	200	200		WJS
Clean Up	5	MSF	27	135	2	10		
Ladders/Scaffold	1	Job	-	-	75	75		3
Subtotal				435		285		
				11-54				

CONSTRUCTION COST ESTIMATE

DATE PREPARED 8/5/81 | SHEET 3 OF 3

PROJECT: REDUCE EXHAUST AND OUTSIDE AIR

LOCATION: WATERVLIET BUILDING 44 BASEMENT

ARCHITECT ENGINEER: PLANNING RESEARCH CORP.

BASIS FOR ESTIMATE
- ☐ CODE A (NO DESIGN COMPLETED)
- ☐ CODE B (PRILIMINARY DESIGN)
- ☐ CODE C (FINAL DESIGN)
- ☐ OTHER (SPECIFY)

DRAWING NO.	COST AS OF (DATE)	ESTIMATOR	CHECKED BY
	1/1/80	W. J. Spillman	

1880 Means (REFERENCES)	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST	REFER. PAGE
(Electrical)								
Min - Med - Max Switch Sta	1	EA	21	21	67	67		210
Conduit - 1 in.	450	LF	1.98	891	.88	396		172
Wire #10 ThWN	1350	LF	.128	173	.09	122		192
Relay	12	EA	10.70	128	8.50	102		206
Transformer	12	EA	10.70	128	32	384		207
Conduit/Box Connectors	40	EA	1.43	57	.93	37		175
Terminations	60	EA	1.13	68	.26	16		196
Pullboxex	12	EA	1605	198	5	60		204
RA/OA/Fan Controls	1	EA	790	790	3163	3163		151/152
Subtotal				2454		4347		

ECO # 17

INSTALL DOUBLE-PANE WINDOWS

Many of the buildings at WVA have single pane windows. Energy savings can be acheived by replacing the existing windows with double-pane windows or by adding storm windows.

Although there are many different types and sizes of windows at WVA, one type of window will be used to evaluate the effectiveness of window retrofit.

This analysis uses a standard Aluminum Frame, 2'-8" x 6'-8" opening to evaluate 2-Pane windows.

Current Energy Use:

Heating Load $= U_w \times A_w \times (68° - \text{O.A.T.}) = Q_H$

Cooling Load $= U_w \times A_w \times (\text{O.A.T.} - 75°F) = Q_C$

For single glazed, Aluminum Frame : $U_w = 1.31$ Btu/hr·SF·°F

Source: ASHRAE 1989 Fund. Handbook, Pg. 27.16

The load calculations were performed using a spreadsheet computer program with bin temperatures for Albany, NY and the above equations. The results are shown on the following page and below.

Q_H = 4.374 mBtu/yr, Fuel Oil #6

Q_C = 0.112 mBtu/yr, Electricity

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 03/25/92
Window Heating and Cooling Load Savings WINDOW.WQ1

INPUTS:			
1)	Days Per Week That HVAC Operates		7 Days/Week
2)	Summer Room Dry Bulb Temperature		75 'F (db)
3)	Winter Room Dry Bulb Temperature		68 'F (db)
4)	Window Overall U-Value		1.31 Btu/Hr*SF*'F
6)	Surface Area of Window		17.8 SqFt
7)	HVAC Oper. Hrs/Shift:	12 M - 8 AM	8 Hrs/Shift
		8 AM - 4 PM	8 Hrs/Shift
		4 PM - 12 M	8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper.	Window Load (Btu/Yr)	
db-Range		wb	00-08	08-16	16-24	Hours	Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	3,587	0
90	94	72	0	28	6	34	13,463	0
85	89	71	0	95	28	123	34,380	0
80	84	68	4	177	73	254	41,415	0
75	79	66	27	248	140	415	19,333	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	101,604
55	59	52	274	190	236	700	0	179,356
50	54	48	263	183	214	660	0	245,974
45	49	43	242	183	205	630	0	308,166
40	44	38	229	202	205	636	0	385,172
35	39	34	261	241	251	753	0	543,728
30	34	30	295	220	262	777	0	651,551
25	29	25	216	156	191	563	0	537,672
20	24	20	163	112	130	405	0	433,948
15	19	16	110	79	96	285	0	338,563
10	14	11	84	43	65	192	0	250,446
5	9	6	60	27	38	125	0	177,609
0	4	2	37	16	22	75	0	115,300
-5	-1	-3	27	3	9	39	0	64,498
-10	-6	-8	10	0	4	14	0	24,784
-15	-11	-13	5	0	0	5	0	9,434
-20	-16	-17	3	0	0	3	0	6,010
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0
Totals			2922	2914	2920	8756	112,179	4,373,813

	Cooling	Heating
Total operating hours for each system	833	6589
Average outside air temp. while cooling/heating	80.8	39.5

SUBJECT WVA - Window Retrofit
AEP NO 290-0379-002
SHEET 3 OF
DESIGNER W.T. Todd
DATE
CHECKER
DATE

Current Heating Energy Use = Q_H ÷ Boiler Eff.

Heating Energy = $4.374 \frac{mBtu}{Yr} \div 0.80 = \underline{5.47 \frac{mBtu}{YR}}$ (F.O. #6)

Current Cooling Energy Use = Q_C × Cooling COP

Cooling Energy = $0.112 \frac{mBtu}{Yr} \times \frac{1.2\ kW}{12000\ Btu} \times \frac{3413\ Btuh}{KWH} = \underline{0.04 \frac{mBtu}{YR}}$ (Elec)

Future Energy Use:

Use double glazed, Aluminum Frame w/ thermal break:

$U_w = 0.70$ Btu/Hr · Ft² · °F

Source: ASHRAE, Fund. Handbook, Pg. 27.16.

The same spreadsheet computer program was used to calculate the heating and cooling loads. The results are shown on the following page and listed below:

$Q_H = 2.337$ mBtu/yr

$Q_c = 0.060$ mBtu/yr

Future Heating Energy Use = Q_H ÷ Boiler Eff.

Heating Energy = $2.337 \frac{mBtu}{Yr} \div 0.8 = \underline{2.92 \frac{mBtu}{Yr}}$ (F.O. #6)

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 03/25/92
Window Heating and Cooling Load Savings WINDOW.WQ1

INPUTS:
1) Days Per Week That HVAC Operates 7 Days/Week
2) Summer Room Dry Bulb Temperature 75 °F (db)
3) Winter Room Dry Bulb Temperature 68 °F (db)
4) Window Overall U-Value 0.70 Btu/Hr*SF*°F
6) Surface Area of Window 17.8 SqFt
7) HVAC Oper. Hrs/Shift: 12 M - 8 AM 8 Hrs/Shift
8 AM - 4 PM 8 Hrs/Shift
4 PM - 12 M 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total	Window Load (Btu/Yr)	
db-Range		wb	00-08	08-16	16-24	Oper. Hours	Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	1,917	0
90	94	72	0	28	6	34	7,194	0
85	89	71	0	95	28	123	18,371	0
80	84	68	4	177	73	254	22,130	0
75	79	66	27	248	140	415	10,331	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	54,292
55	59	52	274	190	236	700	0	95,839
50	54	48	263	183	214	660	0	131,436
45	49	43	242	183	205	630	0	164,669
40	44	38	229	202	205	636	0	205,817
35	39	34	261	241	251	753	0	290,542
30	34	30	295	220	262	777	0	348,157
25	29	25	216	156	191	563	0	287,305
20	24	20	163	112	130	405	0	231,881
15	19	16	110	79	96	285	0	180,912
10	14	11	84	43	65	192	0	133,826
5	9	6	60	27	38	125	0	94,905
0	4	2	37	16	22	75	0	61,611
-5	-1	-3	27	3	9	39	0	34,465
-10	-6	-8	10	0	4	14	0	13,243
-15	-11	-13	5	0	0	5	0	5,041
-20	-16	-17	3	0	0	3	0	3,211
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0
Totals			2922	2914	2920	8756	59,943	2,337,152

	Cooling	Heating
Total operating hours for each system	833	6589
Average outside air temp. while cooling/heating	80.8	39.5

RS&H

SUBJECT: WVA - Window Retrofit
AEP NO: 290-0379-002
SHEET: 5 OF
DESIGNER: W. T. Todd
DATE:
CHECKER:
DATE:

Future Cooling Energy Use = $Q_c \times$ Cooling COP

Cooling Energy $= 0.060 \frac{mBTU}{YR} \times \frac{1.2 \text{ kW}}{12000 \text{ Btu}} \times \frac{3413 \text{ Btuh}}{\text{KWH}} = \underline{0.02 \frac{mBtu}{Yr}}$ (Elec)

Energy Savings:

Heating Energy Savings = Current - Future

Energy Savings $= (5.47 - 2.92) \frac{mBtu}{Yr} = \underline{2.55 \frac{mBtu}{Yr}}$, F.O. #6

Cooling Energy Savings:

Energy Savings $= (0.04 - 0.02) \frac{mBtu}{Yr} = \underline{0.02 \frac{mBtu}{Yr}}$, Elec.

Note: These Savings are on a per window basis.

Project Costs:

Construction Cost = $476 per window

See Cost Estimate Sheets for details

03/25/92

ECO Construction Cost Estimate
Calculations

ECO Name: Install Double-Pane Windows

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$248
Labor		$76
	Subtotal bare costs	$324
FICA Insurance (20% of Labor)		$15
Sales Tax (Not Applicable For GOGO)		$0
	Subtotal	$339
Overhead (15%)		$51
	Subtotal	$390
Profit (10%)		$39
	Subtotal	$429
Bond (1%)		$4
	Subtotal	$433
Contingency (10%)		$43
Subtotal (Construction Cost Input For LCCID *)		$476
SIOH (6.0% of Construction Cost)		$29
	Subtotal	$505
Design (6.0% of Construction Cost)		$29
Total Project Cost		$534

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE	DATE PREPARED 3-25-92	SHEET 7 OF

PROJECT ENERGY ENGINEERING ANALYSIS	BASIS FOR ESTIMATE
LOCATION WATERVLIET ARSENAL	☒ CODE A (No design completed)
	☐ CODE B (Preliminary design)
ARCHITECT ENGINEER REYNOLDS, SMITH AND HILLS A.E.P., INC.	☐ CODE C (Final design)
	☐ OTHER (Specify)

DRAWING NO. N/A	ESTIMATOR W. T. Todd	CHECKED BY

2-Pane Windows SUMMARY	QUANTITY		LABOR		MATERIAL		TOTAL COST
	NO. UNITS	UNIT MEAS.	PER UNIT	TOTAL	PER UNIT	TOTAL	
Aluminum Window, incl Double Glazing, Single Hung, 2'-8" x 6'-8"	1	EA	48	48	248	248	296
Install in Masonry, +5%	1	EA	3	3	-0-	-0-	3
Remove old window	1	EA	25	25	-0-	-0-	25
Subtotals				76		248	324
Source: Means Building Construction Cost Data, 1991, P.193							

ENG FORM 150
1 AUG 59

(ER 1110-345-730)) PREVIOUS EDITION MAY BE USED

* U.S. GOVERNMENT PRINTING OFFICE : 1959 O—510146

(TRANSLUCENT)

ECO # 18

INSTALL STORM WINDOWS

This analysis uses a standard aluminum frame, Double hung, 2'-6" x 5'-0" opening to evaluate storm windows.

Current Energy Use:

The same spreadsheet used for 2-Pane windows was used for this analysis. The results are shown on the next page and listed below.

$$Q_H = 3.075 \text{ mBtu/yr}, \text{ Fuel Oil \#6}$$

$$Q_c = 0.079 \text{ mBtu/yr}, \text{ Electricity}$$

$$\text{Heating Energy} = 3.075 \frac{\text{mBtu}}{\text{yr}} \div 0.8 = \underline{3.84 \frac{\text{mBtu}}{\text{yr}}, \text{ F.O. \#6}}$$

$$\text{Cooling Energy} = 0.079 \frac{\text{mBtu}}{\text{yr}} \times \frac{1.2 \text{ kw}}{12000 \text{ Btu}} \times \frac{3413 \text{ Btuh}}{\text{kwh}} = \underline{0.03 \frac{\text{mBtu}}{\text{yr}}, \text{ Elec.}}$$

Future Energy Use:

Assume storm window combined with existing window is not quite as effective as a double pane window (U_w = 0.70 for 2-Pane)

$$U_w = 0.80 \text{ Btu/hr} \cdot \text{ft}^2 \cdot {}^\circ\text{F}$$

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 03/25/92
Window Heating and Cooling Load Savings WINDOW.WQ1

INPUTS:		
1)	Days Per Week That HVAC Operates	7 Days/Week
2)	Summer Room Dry Bulb Temperature	75 °F (db)
3)	Winter Room Dry Bulb Temperature	68 °F (db)
4)	Window Overall U-Value	1.31 Btu/Hr*SF*°F
6)	Surface Area of Window	12.5 SqFt
7)	HVAC Oper. Hrs/Shift: 12 M - 8 AM	8 Hrs/Shift
	8 AM - 4 PM	8 Hrs/Shift
	4 PM - 12 M	8 Hrs/Shift

Temperatures			Hours of Occurrence			Total Oper.	Window Load (Btu/Yr)	
db-Range		wb	00-08	08-16	16-24	Hours	Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	2,522	0
90	94	72	0	28	6	34	9,465	0
85	89	71	0	95	28	123	24,170	0
80	84	68	4	177	73	254	29,115	0
75	79	66	27	248	140	415	13,591	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	71,428
55	59	52	274	190	236	700	0	126,088
50	54	48	263	183	214	660	0	172,920
45	49	43	242	183	205	630	0	216,641
40	44	38	229	202	205	636	0	270,777
35	39	34	261	241	251	753	0	382,242
30	34	30	295	220	262	777	0	458,042
25	29	25	216	156	191	563	0	377,984
20	24	20	163	112	130	405	0	305,066
15	19	16	110	79	96	285	0	238,011
10	14	11	84	43	65	192	0	176,064
5	9	6	60	27	38	125	0	124,859
0	4	2	37	16	22	75	0	81,056
-5	-1	-3	27	3	9	39	0	45,342
-10	-6	-8	10	0	4	14	0	17,423
-15	-11	-13	5	0	0	5	0	6,632
-20	-16	-17	3	0	0	3	0	4,225
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0
Totals			2922	2914	2920	8756	78,862	3,074,799
Total operating hours for each system							833	6589
Average outside air temp. while cooling/heating							80.8	39.5

The same spread sheet computer program was used to calculate the Future heating and cooling Loads. The results are shown on the next page and listed below.

$$Q_H = 1.878 \text{ mBtu/Yr}, \quad \text{F.O. \#6}$$

$$Q_C = 0.048 \text{ mBtu/Yr}, \quad \text{Elect.}$$

$$\text{Heating Energy} = 1.878 \frac{\text{mBtu}}{\text{Yr}} \div 0.8 = \underline{2.35 \frac{\text{mBtu}}{\text{Yr}}, \text{ F.O. \#6}}$$

$$\text{Cooling Energy} = 0.048 \frac{\text{mBtu}}{\text{Yr}} \times \frac{1.2 \text{ KW}}{12000 \text{ Btu}} \times \frac{3413 \text{ Btuh}}{\text{Kwh}} = \underline{0.02 \frac{\text{mBtu}}{\text{Yr}}, \text{ Elec}}$$

Energy Savings = Current - Future

$$\text{Heating Energy} = (3.84 - 2.35) \frac{\text{mBtu}}{\text{Yr}} = \underline{1.49 \frac{\text{mBtu}}{\text{Yr}}}, \text{ F.O. \#6}$$

$$\text{Cooling Energy} = (0.03 - 0.02) \frac{\text{mBtu}}{\text{Yr}} = \underline{0.01 \frac{\text{mBtu}}{\text{Yr}}}, \text{ Elec}$$

Note - these savings are on a per window basis

Project Costs :

Construction Cost = $\underline{\#101 \text{ per window}}$

See Cost Estimate Sheets for details.

PROJECT: WATERVLIET ARSENAL LIMITED ENERGY STUDY 03/25/92
Window Heating and Cooling Load Savings WINDOW.WQ1

INPUTS:
1) Days Per Week That HVAC Operates — 7 Days/Week
2) Summer Room Dry Bulb Temperature — 75 °F (db)
3) Winter Room Dry Bulb Temperature — 68 °F (db)
4) Window Overall U-Value — 0.80 Btu/Hr*SF*°F
6) Surface Area of Window — 12.5 SqFt
7) HVAC Oper. Hrs/Shift: 12 M - 8 AM — 8 Hrs/Shift
8 AM - 4 PM — 8 Hrs/Shift
4 PM - 12 M — 8 Hrs/Shift

Temperatures			Hours of Occurrence			Total	Window Load (Btu/Yr)	
db-Range		wb	00-08	08-16	16-24	Oper. Hours	Cooling	Heating
120	124					0	0	0
115	119					0	0	0
110	114					0	0	0
105	109					0	0	0
100	104					0	0	0
95	99	75	0	7	0	7	1,540	0
90	94	72	0	28	6	34	5,780	0
85	89	71	0	95	28	123	14,760	0
80	84	68	4	177	73	254	17,780	0
75	79	66	27	248	140	415	8,300	0
70	74	64	115	257	222	594	0	0
65	69	61	234	235	271	740	0	0
60	64	57	263	212	252	727	0	43,620
55	59	52	274	190	236	700	0	77,000
50	54	48	263	183	214	660	0	105,600
45	49	43	242	183	205	630	0	132,300
40	44	38	229	202	205	636	0	165,360
35	39	34	261	241	251	753	0	233,430
30	34	30	295	220	262	777	0	279,720
25	29	25	216	156	191	563	0	230,830
20	24	20	163	112	130	405	0	186,300
15	19	16	110	79	96	285	0	145,350
10	14	11	84	43	65	192	0	107,520
5	9	6	60	27	38	125	0	76,250
0	4	2	37	16	22	75	0	49,500
-5	-1	-3	27	3	9	39	0	27,690
-10	-6	-8	10	0	4	14	0	10,640
-15	-11	-13	5	0	0	5	0	4,050
-20	-16	-17	3	0	0	3	0	2,580
-25	-21					0	0	0
-30	-26					0	0	0
-35	-31					0	0	0
-40	-36					0	0	0
-45	-41					0	0	0
Totals			2922	2914	2920	8756	48,160	1,877,740

Total operating hours for each system	833	6589
Average outside air temp. while cooling/heating	80.8	39.5

03/25/92

ECO Construction Cost Estimate Calculations

ECO Name: Install Storm Windows

ECO #:

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$56
Labor	$13
Subtotal bare costs	$69
FICA Insurance (20% of Labor)	$3
Sales Tax (Not Applicable For GOGO)	$0
Subtotal	$72
Overhead (15%)	$11
Subtotal	$83
Profit (10%)	$8
Subtotal	$91
Bond (1%)	$1
Subtotal	$92
Contingency (10%)	$9
Subtotal (Construction Cost Input For LCCID *)	$101
SIOH (6.0% of Construction Cost)	$6
Subtotal	$107
Design (6.0% of Construction Cost)	$6
Total Project Cost	$113

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED 3-25-92

SHEET 13 OF

PROJECT ENERGY ENGINEERING ANALYSIS

LOCATION WATERVLIET ARSENAL

ARCHITECT ENGINEER REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- [x] CODE A (No design completed)
- [ ] CODE B (Preliminary design)
- [ ] CODE C (Final design)
- [ ] OTHER (Specify)

DRAWING NO. N/A

ESTIMATOR W. T. Todd

CHECKED BY

Storm Windows SUMMARY	QUANTITY NO. UNITS	QUANTITY UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Alumin. Storm Window,							
w/Screen, 2'-6"x5'-0"	1	Ea	13	13	56	56	69

Source: Means Building Construction Cost Data, 1991, Pg 193

ENG FORM 150
1 AUG 59

(ER 1110-345-730))   PREVIOUS EDITION MAY BE USED   (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—516166

RS&H®

SUBJECT ECO# 19 Occupancy Sensors

AEP NO 290-0379-002

SHEET ___ OF ___

DESIGNER Hutchins

DATE 3/19/92

CHECKER

DATE

Screening Calc's - Restroom

- Calculate savings for typical restroom

Assume lights are on from 0600 to 1800, 12 hrs five days per week - and are only needed 40% of the time

- Estimate payback

Room size	=	500 SF
Lighting load (watts)	=	500 w (1 w/sf, p. 19-10)
Annual lighting hrs.	=	3000 hrs
Annual kwh	=	1500 kwh
Annual MBTU	=	5.1 MBTU
Annual savings (%)	=	60%
Annual savings (MBTU)	=	3.1 MBTU
Installed cost	=	$205
Annual Cost savings	=	$63
Payback (years)	=	3.3 yrs.

Therefore, to achieve a payback less than 4 yrs., restrooms selected should average > 400 sf.

	mat. (1)	labor (2)
Cost estimate	85	$ 37.50
FICA (20%)		7.50
SUBTOTAL	$ 85	$ 45.00

SUBTOTAL	$ 130
OTHER MARKUPS (@ 58%)	75
	$ 205

(1) 5% off list
(2) 1 1/2 hrs @ $25/hr

RS&H®

SUBJECT	ECO# 19 - Occupancy Sensors	AEP NO	
		SHEET	OF
DESIGNER		DATE	
CHECKER		DATE	

Screening Calc.: - Break room

- assume lights are on 50% of the time from 0600 to 1800 or 6 hrs/da. - they are needed for two breaks & lunch - a total time of 2 hrs/da - savings are 67%

- Estimate payback

Room size	=	1000 sf
Lighting load	=	1000 watts (1w/sf)
Annual lighting hrs.	=	1500 hrs
Annual kwh	=	1500 kwh
Annual MBtu	=	5.1 MBTU
Annual savings (%)	=	67%
Annual savings (MBTU)	=	3.4 MBTU
Installed cost	=	$240
annual cost savings	=	$70
Payback (yrs)	=	3.4 yrs

	mat. (1)	labor (2)
Cost Estimate	$114	$37.50
FICA (20%)		7.50
SUBTOTAL	114	$45.00
	$159 -	
OTHER MARK-UPS (58%)	92	
	$241	

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SUBJECT ECO#
Occ. Sensors
DESIGNER Hutchins
CHECKER
AEP NO
SHEET ____ OF ____
DATE
DATE

Screening Calc's - Office

Calculate current energy use, savings, payback

Room size	= 15'x 10' = 150 sf.
Lighting load	= 192 watts (2 F40 fixtures)
Annual lighting hours	= 2500 hrs (10 hr/da)
Annual kwh	= 480 kwh
Annual MBtu	= 1.64 MBtu
Annual savings (%)	= 25%
Annual savings (MBtu)	= 0.4 MBtu
Annual cost savings (@ $20/MBtu)	= $8.3
Installed cost	= $96
Payback	= 12 yrs.

	Mat[1]	Lab[2]
Cost Estimate	$53	$6.25
FICA (20%)		1.25
SUBTOTAL	$53	$7.50
	$60.50	
OTHER MARK UPS (@ 58%)	35.09	
	$95.59	

(1) 5% off list
(2) 1/4 hr @ $25/hr.

RS&H®

SUBJECT ECO #19 Occupancy Sensor | AEP NO
SHEET ____ OF ____
DESIGNER | DATE
CHECKER | DATE

Based on screening calculations, restrooms and breakrooms are recommended. Since our survey indicated that most break room areas lighting were turn off when not occupied. Restrooms lights have a greater tendency to be left on when unoccupied.

RS&H®

SUBJECT: ECO #19 Occupancy Sensor | AEP NO:
SHEET: OF:
DESIGNER: | DATE:
CHECKER: | DATE:

QRIP/OSD PIF CALC.S

PRESENT METHOD ENERGY USE

FROM p. 19-1 annual MBTU = 3.1 MBTU / 500 sf

p. 19-6 bath sf = 34,136

FOR 34,136 sf ⇒ 34,136 * 5.1/500 = 348 MBTU/yr.

Cost = 348 MBTU * $20.35/MBTU = $7080 /yr.

PROPOSED METHOD ENERGY USE

FROM p. 19-1 (5.1-3.1) MBTU/500 sf

34,136 * 2.0 MBTU/500 sf = 137 MBTU/yr.

Cost = 92 * $20.35/MBTU = $2790/yr

SAVINGS

ENERGY = 348 - 137 = 211 MBTU/yr

COST = 7080 - 2790 = $4290/yr

WATERVLIET ARSENAL
ECO #19 OCCUPANCY SENSORS

RESTROOM INVENTORY

BLDG #	#	DIMENSIONS	AREA (SF)	NOTES
10	3	10X16,16X19,14X19(2)	996	1ST FLOOR
	3	10X16,16X19,14X19(2)	996	2ND FLOOR
	4	10X15(2),8X16,12X15	608	3RD FLOOR
	1	12X18	216	BASEMENT
15	1	13*32	416	
20	2	40X70	5600	
21	4	15X16(2),10X10(2)	680	
22	-	-	-	
23	-	-	-	
24	3	15X17,17X21(2)	969	
25	3	35X45	4725	LADIES' LOCKERS
	3	30X30	1800	MEN'S LOCKERS
35	2	40X50	4000	MAIN FLOOR MEN'S/LADY'S LOCKERS
	1	34X38	1292	BASEMENT MEN'S LOCKER
40	2	20X30	1200	1ST FLOOR SOUTH-MOST WING
	2	20X30	1200	1ST FLOOR NORTH END
	2	15X20,10X30	600	1ST FLOOR NORTH-MOST WING
44	1	18X20	360	BASEMENT
	2	18X20(2)	720	1ST FLOOR WEST END
110	2	13X20,8X20	420	MAIN FLOOR
	1	15X20	300	NORTH END
	2	10X20,9X24	416	SOUTH END
115	2	15X15	450	
120	2	20X20	800	1ST FLOOR - SOUTH
	3	13X20(2),10X20	720	2ND FLOOR
124	-	-	-	
125	4	3/4(38X80),16X26,16X18(2)	3272	MAIN FLOOR - NORTH
130	-	-	-	
135	2	20X20	800	
145	2	10X18,20X20	580	
TOTALS	59		34,136	

LOCATIONS ARE FOUND ON FLOOR PLANS IN VOL. III A

RS&H®

SUBJECT ECO# 19 Occupancy Sensors

AEP NO

SHEET ____ OF ____

DESIGNER

DATE

CHECKER

DATE

- Calculate annual replacement costs
  Life expectancy = 12 yrs.
  Therefore all sensors will be replaced once ~~of~~ at the end of 12 years and the replacement will operate until the end of the 25 yr. study life

Cost of replacement (see p. 19-1) $130 * 59 = $7670

No other mark up since you would be using installation labor

03/31/92

ECO Construction Cost Estimate Calculations

ECO Name: OCCUPANCY SENSORS

ECO #: 19

1991 ECO "bare" costs (from cost estimate sheet)		
Material		$5,369
Labor		$2,213
	Subtotal bare costs	$7,582
FICA Insurance (20% of Labor)		$443
Sales Tax (not applicable for GOGO)		$0
	Subtotal	$8,025
Overhead (15%)		$1,204
	Subtotal	$9,229
Profit (10%)		$923
	Subtotal	$10,152
Bond (1%)		$102
	Subtotal	$10,254
Contingency (10%)		$1,025
Subtotal (Construction Cost Input For LCCID *)		$11,279
SIOH (6% of Construction Cost)		$677
	Subtotal	$11,956
Design (6% of Construction Cost)		$677
Total Project Cost		$12,633

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE	DATE PREPARED 3/31/92	SHEET OF

PROJECT	BASIS FOR ESTIMATE
ENERGY ENGINEERING ANALYSIS	☐ CODE A (No design completed)
LOCATION: WATERVLIET ARSENAL	☒ CODE B (Preliminary design)
ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.	☐ CODE C (Final design) ☐ OTHER (Specify)

DRAWING NO.	ESTIMATOR	CHECKED BY
ECO#19	P. HUTCHINS	

OCCUPANCY SENSORS SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
Occupancy Sensors	59	ea	37.50	2213	69.00	4071	6284
POWER/SWITCH PACK	59	ea	-	-	22.00	1298	1298
SUBTOTAL				2213		5369	7582
Source: UEC							

ENG FORM 150
1 AUG 59 (ER 1110-345-730) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

RS&H®

SUBJECT ECO #19 Occupancy Sensor

DESIGNER Hutchins

CHECKER

AEP NO

SHEET ___ OF ___

DATE

DATE

ESTIMATED LIGHTING INTENSITY IN RESTROOMS (W/SF)

RESTROOM LIGHTING DATA

EXAMPLES	SIZE (SF)	TOTAL WATTS	WATTS PER SF	FOOT-CANDLES
1	1080	576	0.5	15
2	196	192	1.0	30
3	225	480	2.1	50
4	308	480	1.6	70
5	504	288	0.6	30
6	468	576	1.2	90
7	516	672	1.3	75
TOTAL	3297	3264	1.0	

AVG 471

RS&H **Telephone Call Confirmation**

Project No. 290-0379-002

Local ____ L.D. ✓ Placed ✓ Rec'd. ____ Date 3/19/92

P. Hutchins Conversed With Rich

Of UNENCO Regarding Occupancy Sensors

(214) 442-1900

	Type	COST MAT	COST LAB
BATHROOM	OVERHEAD u/s		3/4 hr dropped
	C600-R		? solid
Classroom	PIR OVERHEAD		
	or WALL MO SOM 1200 2HD		1/4 hr.
Hallway	C500.2000 15X100		
	u/s		
Office	wall-mount switch		
	16X25 7.5AMP SOM-500-A PIR		
~~[illegible]~~	min. 34X34 SOM-1000-B		
Breakroom	min. 34X34 7.5AMP SOM-1000-A2 PIR		

Carpet affects u/s

10 yr life expectancy

UNENCO & UEC ARE SAME COMPANY

DO NOT HAVE PHOTOCELL RIGHT NOW.

SUBTRACT 7.5%-10%

Distribution:

19-11

UEC®

Manufacturers & Designers of Sensible Controls

January 1992

Switchomat™

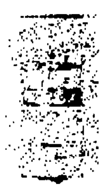
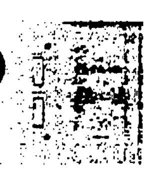
The world's best investment in automatic light switching ....with a 9-year proven track record!

$50 invested now will earn a $500 return by 1999

Automatic Light Switch

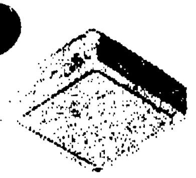
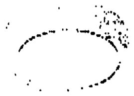
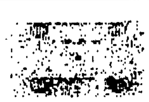
Now you can replace your forgetful switches and have aesthetically pleasing, automatic switches by means of infrared occupancy sensors. Ultra safe, no heat generating components, installed in minutes. Total equipment cost is only $48.00 in quantities of 250 and up. *Switchomat*™ controls an area up to 800 square feet and 1800 watts. Pay back is less than one year, based on 350 watt load at 8¢ per KWH. UEC is the leader and innovator in infrared and ultra-sonic occupancy sensors for small, medium or large areas, including HVAC controls. All products are covered by a five year factory warranty and a 90 day money back guarantee.

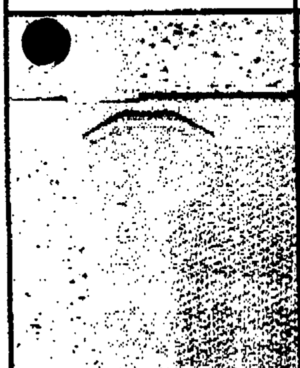
PASSIVE INFRARED AUTOMATIC 2 WIRE WALL LIGHT SWITCHES

Model	Description	1-23	24-95	96 & UP
 Model SOM-500-A	***Switchomat***™ Manual lights off switch with built-in safety neon night light. Occupancy sensor, up to 800 sq. ft. coverage. 120/277 Volt, 1000/1800 Watt switching capacity fluorescent or incandescent. Immediate activation when entering room.	$60.00	$56.00	$52.00
 Model SOM-1000-A	***Switchomat***™ Occupancy sensor, up to 1000 sq. ft. coverage. 120/277 Volt, 1000/1800 Watt switching capacity fluorescent or incandescent, 180° coverage. Immediate activation when entering room.	64.00	60.00	56.00
 Model SOM-1000-A-2	***Switchomat***™ 2 switches, 2 circuits. Occupancy sensor, up to 1000 sq. ft. coverage. 120/277 Volt, 1000/1800 Watt switching capacity on each circuit (2 wires) 180° coverage. Immediate activation when entering room. *Heavy duty model with larger switching capacity available upon request.*	70.00	66.00	62.00
 Model SOM-1000-B	***Switchomat***™ Occupancy sensor, up to 1000 sq.ft. coverage. Single circuit heavy load capacity. Minimum 900 Watt to Maximum 2400 Watt at 120V ballast rating. Minimum 1800 Watt to Maximum 4500 Watt at 277V ballast rating, 180° coverage. Immediate activation when entering room.	71.00	67.00	63.00
 Model SOM-1200-2-HD	***Switchomat***™ MODEL SOM-1200-2-HD, SPECIFICALLY DESIGNED FOR CLASSROOMS. 2 switches, 2 circuits, occupancy sensor, up to 4000 sq. ft. coverage, 120/277V, 2000/4000 Watt switching capacity on each circuit (2 wires) 180° coverage. Immediate activation when entering. Can be mounted in either a double or triple gang wall box or plaster ring.	96.00	92.00	88.00

MAR 19 '92 10:37 UNIVERSAL ENERGY 214+442+4198 P.2
19-12

Conserver™ CEILING MOUNTED SAFE ULTRASONIC OCCUPANCY SENSORS SWITCH LIGHTS AND HVAC ON/OFF AUTOMATICALLY

		1-23	24-95	96 & UP
 Model C-400 Model C-600-H Model HMS-1 Size: 4" x 4" x 1"	**MODEL C-400, Occupancy sensor 400 sq. ft. coverage. For use with remote power switch packs, or can be mounted together with power switch pack.**	$62.00	$58.00	$54.00
	MODEL C-600-H, Selected and modified for hallway installations. For use with remote power switch packs, or can be mounted together with power switch pack.	69.00	65.00	61.00
	MODEL HMS-1, Room Occupancy sensor with built-in comfort cycle timer. 400 sq. ft. coverage for Hotel/Motel guest room HVAC control. For use with remote power switch packs, or can be mounted together with power switch pack.	78.00	73.00	69.00
 Model C-600-R Size: 4.25" x 1"	**MODEL C-600-R, Occupancy sensor 600 sq. ft. coverage equipped with versatile transmitter power slide switch feature for use in small rooms. For use with remote power switch packs, or can be mounted together with power switch pack.**	69.00	65.00	61.00
 Model C-1000 Size: 5" x 1"	**MODEL C-1000, Occupancy sensor 1000 sq. ft. coverage or for multiple unit installation in large open offices. For use with remote power switch packs, or can be mounted together with power switch pack.**	80.00	76.00	72.00
 Model C-500-2000 Size: 5" x 3⅜" x 1⅜"	**MODEL C-500-2000, Occupancy sensor, 2000 sq. ft. coverage or for multiple unit installations in large open offices. Also suitable for long hallways 100' x 15'. For use with remote power switch packs, or can be mounted together with power switch pack.**	98.00	93.00	88.00



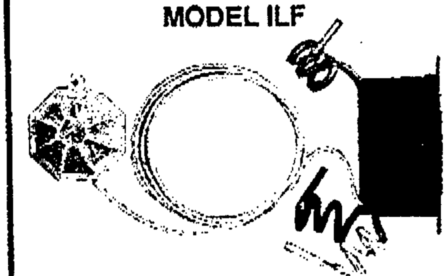
NEW! NEW!

INTELLIGENT LIGHT FIXTURE

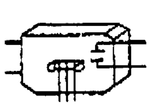
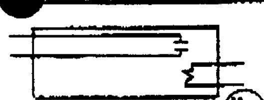
Now you can make any light fixture, or even a bank of lights turn on and off automatically. By using the superbly engineered infrared sensor/power switch pack combination, it can be installed inside a fixture ballast channel in less than 15 minutes without disturbing the existing ceiling or wiring.

Patent Pending

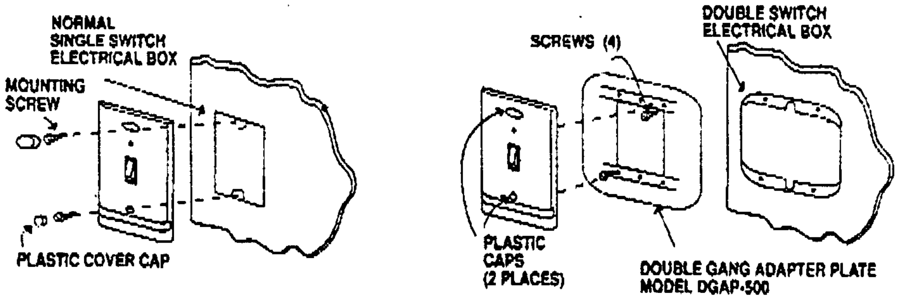
MODEL ILF



Call or write for free feasibility analysis!

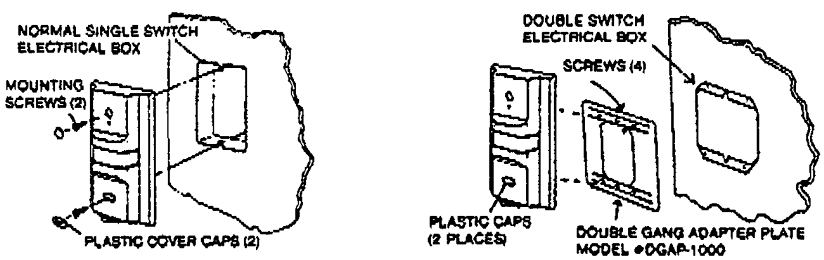
	REMOTE POWER/SWITCH PACKS			
 Size: 2¾" x 1⅝" x 1⅝"  Model 211, 212 & 213	**MODEL 211, Power/Switch Pack, 120V, with isolated relay contacts. 20 AMP Ballast rating. 40 year life expectancy rated at full load.** ***Heavy duty power packs for motor loads available upon request.***	22.00	20.00	18.00
	MODEL 212, Power/Switch Pack, 208V/240V, with isolated relay contacts. 20 AMP Ballast rating. 40 year life expectancy rated at full load. ***Heavy duty power packs for motor loads available upon request.***	22.00	20.00	18.00
	MODEL 213, Power/Switch Pack, 277V, with isolated relay contacts. 20 AMP Ballast rating. 40 year life expectancy rated at full load. ***Heavy duty power packs for motor loads available upon request.***	22.00	20.00	18.00
 Model SRP-1	**MODEL SRP-1, Slave Relay Pack, 20 AMP Ballast rating. 40 year life expectancy rated at full load.**	12.00	11.00	10.00

Model SOM-500 Accessory



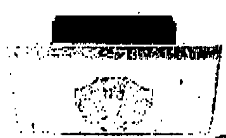
1-23	24& Up
$2.75	$2.50

Model SOM-1000 Accessory



1-23	24& Up
$2.75	$2.50

CEILING MOUNTED PASSIVE INFRARED OCCUPANCY SENSORS

		1-23	24-95	96 & UP
 MODEL PIR-1000-P Size 3" x 4¾" x 1¼"	**Conserver™** PIR-1000-P, self contained occupancy sensor, up to 1000 sq. ft. coverage, 20 amp switching capacity. Specify voltage when ordering.	$68.00	$64.00	$62.00
MODEL PIR-1000-P-H Size 3" x 4¾" 1¼"	For long hallways and warehouses, specify type H-P, 16' x 80' coverage. Specify voltage when ordering.	75.00	71.00	67.00
MODEL PIR-2000-P Size 3" x 4¾" x 1¼"	For large areas of detection 45' x 45', specify PIR-2000-P. Specify voltage when ordering.	95.00	90.00	85.00
 MODEL PIR-1000 Size 3" x 4¾" x 1¼"	**Conserver™** PIR-1000, Occupancy sensor up to 1000 sq. ft. coverage. For use with remote power switch pack.	60.00	56.00	52.00
MODEL PIR-1000-H Size 3" x 4¾" x 1¼"	For long hallways and warehouse specify type "H", 16' x 80' coverage.	65.00	61.00	57.00
MODEL PIR-2000 Size 3" x 4¾" x 1¼"	For large areas of detection 45' x 45', specify PIR-2000.	85.00	80.00	75.00

OTHER BACKUP CALCULATIONS

O&M ENERGY SAVINGS

BACK-UP CALCULATIONS

RS&H®

SUBJECT O&M Savings
34 Watt Fluorescents
DESIGNER P. Hutchins
CHECKER

AEP NO 290-0379-004
SHEET ____ OF ____
DATE 3/18/92
DATE

Upon failure, replace 40-watt fluorescent lamps with 34-watt lamps.

Energy savings:

Non production area:

$(40-34)\text{ watts} * \frac{1\text{ kw}}{1000\text{ w}} * 2340\frac{\text{hr}}{\text{yr}} = \underline{14}\text{ kWh/yr}$

Production area

$(40-34) * 8400\frac{\text{hrs}}{\text{yr}} \div 1000 = \underline{50}\text{ kwh/yr}$

Energy Cost Savings

Non production : 14 * \$0.068/kwh = \$0.95/yr

Production : 50 * \$0.068/kwh = \$3.40/yr

Material Cost Differential

\$3.05 - 2.4 = \$0.81 /lamp   MEANS Electrical Cost Data 1991 p. 201

Payback

Non-Production : 0.81 ÷ 0.95 = 0.9 years

Production : 0.81 ÷ 3.40 = 0.25 years

OM-1

RS&H

SUBJECT O&M Savings
Energy Efficient Ballasts

DESIGNER Hutchins

CHECKER

AEP NO 290-0379-002

SHEET OF

DATE 3/31/92

DATE

Upon failure replace standard fluorescent ballast with energy efficient type

Ballast Data

Four Foot Fluorescents

TYPE	FIXTURE (1) (WATTS)	COST GSA	COST VENDOR
STANDARD	96	$ 7.75	
EEE (2)	80	10.30 (3)	$ 20.00
ELECTRONIC	71	13.00 (3)	25.20

Eight Foot Fluorescents

TYPE	FIXTURE (1) WATTS	COST GSA	COST VENDOR
STANDARD	175	$ 11.76	
EEE (2)	158	—	—
ELECTRONIC	130	$ 19.10	35.00

(1) 2-40 watt lamps

(2) EEE = energy efficient electromagnetic ballast

(3) estimated based on cost data on eight foot lamps

RS&H®

SUBJECT O&M Savings
Fluorescent Ballasts

DESIGNER

CHECKER

AEP NO

SHEET OF

DATE 3/31/92

DATE

Energy savings:

Production areas: $(\text{watts}_{STND} - \text{watts}_{ALT}) * 24 h/da * 5 da/wk * 50 wk/yr.$

Non Production: $(W_S - W_A) * 10 h/da * 5 da/wk * 50 wk/yr.$

TYPE	AREA	ANNUAL SAVINGS (MBTU)	$	PAYBACK (YRS)
EEE-4'	PROD	0.33	6.70	0.4
EEE-4'	NON-PROD	0.14	2.80	1.0
ELEC-4'	PROD	0.51	10.40	0.5
ELEC-4'	NON-PROD	0.21	4.30	1.2
ELEC-8'	PROD	0.92	18.75	0.4
ELEC-8'	NON-PROD	0.14	2.80	1.0

FLUORESCENT BALLAST SPECIFICATIONS
WVA - #290-0379-002
12-Feb-92

LAMPS	WATTS	BALLASTS	BALLAST INPUT (W)	PRICE ($)
F40T12/RS	40	ADV MARK IV	80	$20.00
STD		EBT ELECTRONIC	71	
		GE OPTIMISER	71	
		GE PERFORMANCE SS	70	
		STANDARD	96	
F40T12/RS	34	ADV MARK IV	66	$20.00
ENERGY		EBT ELECTRONIC	59	$25.20
		GE OPTIMISER	59	
F40T12/RS	32	GE MAXI-MISER II	72	
ENERGY				
F40T8/IS	40	EBT ELECTRONIC	70	
STD				
F32T8/IS	32	EBT ELECTRONIC	58	$26.90
ENERGY		T8 MAGNETIC	66	
F96T12/IS	75	GE MAXI-MISER II	158	
STD		EBT ELECTRONIC	130	
		STANDARD	175	
F96T12/IS	60	GE MAXI-MISER II	136	
ENERGY		EBT ELECTRONIC	105	$35.00
F96T12/HO	105	GE WATT-MISER	237	
STD		GE MAXI-MISER II	254	
		STANDARD	255	
		EBT ELECTRONIC	190	
F96T12/HO	95	GE MAXI-MISER II	212	
ENERGY		EBT ELECTRONIC	160	$44.00
F96PG17				
STD	215	STANDARD	460	
ENERGY	185	STANDARD	400	
F90T17				
STD	90	STANDARD	215	
ENERGY	82	STANDARD	200	
F90T12	84	STANDARD	200	

RS&H®

SUBJECT O&M Savings - Repair Compressed Air Leaks

DESIGNER Hutchins

CHECKER

AEP NO 290-0379-002

SHEET ____ OF ____

DATE 3/18/92

DATE

O&M Savings - Compressed Air Leaks

From ASHRAE, a 1/32" hole wastes \$252/yr @ 4¢/kwh

For WVA : $\$252 \cdot \frac{6.8¢}{4¢} = \underline{\underline{\$428}}$ /yr / leak

$$\$428 \div \frac{6.8¢/kwh * 3413\ Btu/kwh}{1.E6} = \underline{\underline{22}}\ MBtu\ /yr\ /leak$$

RS&H®

SUBJECT	Increase Condensate Return to B. 136	AEP NO	290-0379-002
DESIGNER	P. Hutchins	SHEET	OF
CHECKER		DATE	11/15/91
		DATE	

- Calculate the energy savings due to increasing condensate return

- Calculate present energy use

For this analysis boiler logs were collected and reviewed for the period June 1990 to May 1991. These were used in place of fiscal year data since the logs contain concurrent data on fuel use, steam generation and make-up water.

An analysis of this data is shown on the following page.

Present energy use = 301,700 MBtu #6 Fuel Oil

Energy savings = 7100 MBtu

Future energy use = 294,600 MBtu

WATERVLIET ARSENAL
STEAM GENERATION, FUEL USE & CONDENSATE RETURN

FILENAME: STEAM.WQ1 18-Mar-92

ENERGY SAVINGS FOR INCREASING CONDENSATE RETURN EXCEPT FOR PLATING TANKS IN BLDG. 35

MON	YR	STEAM GENERATED BLDG 136 (MBTU) w/ PROCESS	STEAM GENERATED BLDG 136 (MBTU) w/o PROCESS	AVG M-U (%)	#6 FUEL CONSUMED W/ PROCESS (GAL)	#6 FUEL CONSUMED W/ PROCESS (MBTU)	#6 FUEL CONSUMED W/O PROCESS (MBTU)	#6 FUEL CONSUMED W/O PROCESS & 10% MAKE-UP (MBTU)	SAVINGS (MBTU)
6	/ 90	0	0	100	0	0	0	0	0
7		0	0	100	0	0	0	0	0
8		0	0	100	0	0	0	0	0
9		0	0	100	0	0	0	0	0
10		13,050	9,300	66	101,103	15,165	10,808	10,222	586
11		31,774	28,024	52	264,549	39,682	34,999	33,675	1,324
12		40,149	36,399	43	339,326	50,899	46,145	44,794	1,351
1	/ 91	46,563	42,813	34	392,146	58,822	54,085	52,929	1,156
2		41,772	38,022	29	346,357	51,954	47,290	46,477	813
3		38,739	34,989	31	309,436	46,415	41,922	41,096	827
4		25,616	21,866	46	205,867	30,880	26,359	25,474	886
5		6,573	2,823	57	52,610	7,892	3,389	3,240	149
TOTALS		244,236	214,236		2,011,394	301,709	264,997	257,905	7,091

Make up energy use = (old make-up % - 10%) * steam gen'd (#) * 90 Btu/# / 0.80

OM-7

FACILITIES ENGINEERING OPERATING LOG *(Boiler Plant)*

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: Watervliet Arsenal | PLANT: Boiler Plant | BLDG. NO.: 136 | MONTH: Oct 90

Day	Steam Produced #1 (1000 LB.)	Steam Produced #2 (1,000 LB.) (1)	#3 (1,000 LB.) (2)	#4 (1,000 LB.) (3)	#5 (1,000 LB.) (4)	Total (1,000 LB.) (5)	Feed-water to Boiler (1,000 LB.) X (6)/666	Oil Fuel Used LB. M.C.F. GAL. (7)	Evap. LB. per Unit (8)	Outside Temp. Av. °F. (9)	Feedwater Heater Press. LB. (10)	Feedwater Heater Temp. °F. (11)	Feedwater Heater Makeup Gal. X 1000 (12)	%O2 Boiler 5 (13)	%O2 Boiler 2 (14)	%O2 Boiler 3 (15)	Flue Gas Temp. Boiler 1 °F. (16)	Flue Gas Temp. Boiler 2 °F. (17)	Flue Gas Temp. Boiler 3 °F. (18)	Flue Temp 4 (19)	Flue Temp 5 (20)	Make Up % (21)	Eff. (22)	Init. (23)
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18		486.9				486.9		2520	17.2	66.5	6	230	[illegible]					378				64.0	91.7	H.H.
19		689.7			30.8	720.5		5162	17.2	48.1	6	230	52.9	3.7				400			420	73.9	91.7	H.H.
21		700.3			121.4	821.7		5588	18.1	45.5	6	230	69.1	3.5				400			422	72.1	96.5	H.H.
21		667.3			132.4	799.7		5968	16.5	59.5	6	230	58.9	[illegible]				394			[illegible]	71.7	87.9	H.H.
22		656.7			11.8	668.5		4850	17.0	55.0	6	230	54.3	[illegible]				400			[illegible]	67.5	90.6	H.H.
23		705.1				705.1		5266	16.5	53.5	6	230	56.5					407				65.9	87.9	H.H.
24		727.5			9.6	737.1		5015	15.4	49.6	6	230	65.5	3.0				405			[illegible]	78.6	[illegible]	H.H.
25		683.8			291.4	975.2		7671	15.7	46.2	6	230	75.0	2.5				400			447	64.1	83.7	JH
26	311.4	682.9			178.8	1173.1		9439	15.3	43.4	6	230	90.9	1.9			425	411			495	64.5	81.8	JH
27	578.1	600.5				1178.6		9468	15.4	38.2	6	230	87.6	–			417	397			–	61.9	81.9	JH
28	223.1	626.6			154.2	1003.9		7902	15.7	46.7	6	230	74.2	2.6			395	390			427	[illegible]	83.6	JH
29	716.8	669.3				1386.1		11517	14.9	41.2	6	230	97.0	–			432	405			–	58.3	79.2	JH
30	672.2	677.1				1349.3		11094	15.0	43.3	6	230	153.0	–			423	412			–	[illegible]	79.9	JH
31	663.5	295.9			84.7	1044.1		8745	14.7	44.2	6	230	79.4	3.0			413	390			455	[illegible]	72.3	JH
TOT.	3165.1	[illegible]			1015.1	15049.9		101103	224.6	683.9	84	3220	1019.8	26.1			2505	559.2			4029	921.0	[illegible]	
MAX.	716.8	727.5			291.4	1386.1		11517	17.2	66.5	6	230	103.0	3.7			432	412			495	73.9	96.5	
MIN.	223.1	295.9			9.6	486.9		2520	14.7	38.2	6	230	57.4	1.9			413	377			420	58.3	77.3	
AV.	527.5	633.5			112.8	932.1		7221	16.0	47.9	6	230	72.8	2.9			417	399			448	65.8	85.5	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: R. Orenk | DATE: 11/16/90 | APPROVED BY | DATE | POST ENGINEER | DATE

OM-8

file

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 136 | MONTH: NOV. 1990

DAY	STEAM PRODUCED #1 1000 LB.	#2 1000 LB. (1)	#3 1,000 LB. (2)	#4 1,000 LB. (3)	#5 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. X (6)/666	#6 OIL FUEL USED LB. M.C.F. (GAL) (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. X 1000 (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	15 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	FLUE TEMP 4 (19)	FLUE TEMP 5 (20)	MAKE UP % (21)	EFF. (22)	INIT. (23)
1	[illegible]				164.9	808.0		7067	14.0	43.9	6	230	53.3			3.0	420				445	53.9	74.6	LEO
2	578.1				89.5	667.6		5815	14.1	53.3	6	230	45.7			2.8	410				420	57.2	75.1	LEO
3	[illegible]					547.0		4673	14.4	[illegible]	6	230	42.6				410					[illegible]	73.7	LEO
4	549.9					549.9		4827	[illegible]	63.6	6	230	46.4				393					72.5	74.6	LEO
5	671.2	156.2			274.1	1101.5		9459	14.2	47.5	6	230	70.6			3.5	410	380			491	53.4	73.3	LEO
6	567.4	583.9				1151.3		9400	15.1	47.1	6	230	58.8				403	390				42.5	80.6	LEO
7	635.3	613.0				1248.3		10097	15.3	42.4	6	230	59.8				420	405				39.3	81.4	LEO
8	316.2	341.4	608.8			1266.4		[illegible]	15.8	39.3	6	230	63.5				415	390	410			41.8	84.5	RH
9			1194.2		39.2	1233.4		9523	16.2	37.2	6	230	55.5						[illegible]		[illegible]	41.9	[illegible]	RH
10			1041.8			1041.8		7905	16.3	40.2	6	230	80.6						403			64.4	86.8	RH
11			1049.9			1049.9		8410	16.1	37.1	6	230	57.2						407			45.4	86.0	DH
12			1172.1			1172.1		8991	16.1	32.9	6	230	57.2						413			40.6	85.6	RH
13	383.1	369.6	556.4		87.9	1397.0		11567	14.9	30.5	6	230	66.5				425	420	455		455	39.6	79.5	RH
14	644.1	631.4			225.8	1501.3		12203	15.2	33.8	6	230	71.7			3.0	413	407			455	39.8	81.0	RH
15	380.2	695.4			[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	6	230	[illegible]			[illegible]	[illegible]	[illegible]			420	[illegible]	[illegible]	HH
16	165.9	345.4	397.9		97.7	1006.9		7327	13.6	55.5	6	230	53.1			3.5	415	420	[illegible]		[illegible]	45.1	72.5	HH
17			753.1			753.1		5259	14.5	[illegible]	6	230	57.0						406			53.2	77.3	HH
18			941.6		8.4	950.0		9003	13.0	33.2	6	230	61.5			3.0	[illegible]		[illegible]		410	53.9	69.3	HH
19	538.4	551.0	[illegible]		12.9	[illegible]		[illegible]	14.4	34.3	6	230	57.9			3.0	422	412	450		[illegible]	57.1	76.7	HH
21	673.2	658.6				1331.8		[illegible]	14.8	38.9	6	230	69.1				423	406				42.5	78.7	HH
21	656.6	637.3				1293.9		[illegible]	14.8	40.5	6	230	73.0				426	416				46.2	75.9	HH
22	583.9	230.4			133.2	947.0		8022	14.6	44.3	6	230	62.0			2.3	407	390			453	54.5	77.8	JH
23	308.5	608.2			114.3	1031.0		8711	14.6	49.0	6	230	72.0			2.8	410	400			428	58.2	77.9	JH
24		654.8			297.3	952.1		7889	14.9	44.6	6	230	64.9			2.5		417			445	56.8	79.4	JH
25	70.8	[illegible]			256.3	951.8		8037	14.6	46.4	6	230	64.7			2.0	400	400			457	56.6	78.0	JH
26	653.8	606.2				1260.0		10735	14.5	41.8	6	230	69.3				420	413				45.8	77.2	JH
27	547.1	575.2				1122.3		9630	14.3	49.1	6	230	79.4				426	396				58.9	76.2	JH
28	13.6	708.1			90.7	812.4		6666	15.0	60.6	6	230	61.5			2.7	700	403			450	63.0	79.9	JH
29	343.4	619.8			83.0	1046.2		9203	14.0	44.9	6	230	64.5			2.1	425	316			490	50.9	74.6	LEO
30	646.0	642.1				1288.1		10996	14.4	36.4	6	230	75.7				442	450				48.9	76.7	LEO
31																								
16.8 TOTAL	10757.1	7848.6			2051.7	31774.2		264549	443	1321	180	6900	1905.0			36.9	9566	7788	4207		7111	1550.2	2331.7	
23.2 MAXIMUM	708.1	1194.2			297.3	1501.3		12203	16.3	60.8	6	230	80.6			3.0	442	420	450		491	70.3	86.8	
.6 MINIMUM	156.2	232.8			8.4	547.0		4673	13.0	30.5	6	230	42.6			2.0	390	316	403		390	39.3	69.3	
33.3 AVERAGE	537.8	784.8			128.2	1059.1		8818.3	14.7	44.0	6	230	63.5			2.6	425.4	399.4	420.2		444.4	51.6	78.7	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: R. D. [illegible] | DATE: 12/3/90 | APPROVED BY | DATE | POST ENGINEER | DATE

OM-9

File

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 136 | MONTH: DEC - 1990

DAY	STEAM PRODUCED #1 1000 LB	#2 1000 LB. (1)	#3 1,000 LB. (2)	#4 1,000 LB. (3)	#5 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. X (6)/666	FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	MAKEUP GAL. X 1000 (12)	% O2 BOILER 1 (13)	% O2 BOILER 2 (14)	% O2 BOILER 5 O2 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	FLUE TEMP 4 (19)	FLUE TEMP 5 (20)	MAKE UP % (21)	EFF. (22)	INIT. (23)
1	532.5	576.2				1108.7		9443	14.5	42.3	6	230	66.1				436	400				49.6	77.3	LEO
2	420.0	523.8			32.0	975.8		8269	14.5	46.1	6	230	65.3			3.0	410	383			410	55.7	77.3	LEO
3	687.7	664.4				1352.1		11342	14.7	37.6	6	230	80.9				450	413				49.8	78.3	LEO
4	630.5	591.7				1222.2		10316	14.6	44.8	6	230	69.1				440	407				47.1	78.0	LEO
5	714.9	738.1				1453.0		12195	14.7	33.3	6	230	68.9				450	420				39.5	78.4	LEO
6	691.6	731.3				1422.9		11921	14.7	38.8	6	230	70.0				440	413				40.9	78.6	RH
7	647.9	673.2				1321.1		11072	14.7	41.2	6	230	61.2				437	410				41.7	78.5	RH
8	537.4	558.7				1096.1		9146	14.7	42.5	6	230	55.6				430	395				42.2	78.3	JH
9	593.6	620.8				1214.4		10122	14.8	41.0	6	230	53.5				430	403				36.7	79.0	RH
10	621.8	638.2				1260.0		10587	14.7	42.6	6	230	59.6				437	412				39.4	78.2	RH
11	723.6	679.9			123.3	1526.8		12699	14.8	30.9	6	230	66.9			3.2	453	417			447	34.4	78.9	RH
12	671.2	674.1				1345.3		11227	14.8	38.6	6	230	57.3				450	420				35.5	75.5	RH
13	628.6	618.8				1247.4		10520	14.6	45.9	6	230	58.1				447	410				38.8	77.5	HH
14	711.9	693.6			100.5	1505.0		12560	14.8	38.9	6	230	67.2			3.0	453	420			450	37.2	78.8	HH
15	715.9	681.9			41.3	1439.1		13045	14.7	33.3	6	230	74.4			3.2	460	420			[illegible]	[illegible]	[illegible]	HH
16	694.5	703.2				1397.7		11641	14.8	37.2	6	230	61.6				453	423				36.7	79.3	HH
17	682.7	720.7			26.5	1425.9		12112	14.8	37.4	6	230	67.9				446	420			440	29.3	78.9	HH
18	662.5	647.0				1309.5		10869	14.9	43.5	6	230	61.0			3.2	450	417				35.5	79.4	HH
19	662.5	642.1				1304.6		[illegible]	14.5	33.7	6	230	61.4				437	403				39.2	75.7	HH
21	718.8	707.1			101.9	1527.8		12916	14.6	31.9	6	230	71.1			3.3	457	413			450	38.8	77.8	JH
21	685.8	633.4			15.2	1304.4		10997	14.6	45.4	6	230	65.6			3.0	460	407			450	31.9	78.1	JH
22	711.0				15.0	726.0		6412	14.0	51.3	6	230	50.5			3.0	455				450	57.9	73.6	JH
23	704.2				71.3	775.5		6812	14.0	56.9	6	230	51.4				453				430	55.2	74.6	JH
24	743.0	75.7			204.2	1022.9		8780	14.4	36.8	6	230	53.5			2.4	460	410			439	43.6	76.8	JH
25	647.0	598.5			27.4	1272.9		10503	14.4	29.1	6	230	63.3			2.8	450	406			460	41.4	77.3	JH
26	676.1	713.0			253.4	1642.5		14022	14.4	28.9	6	230	74.4			2.6	453	426			456	37.7	76.7	JH
27	657.7	686.7			358.7	1703.1		14599	14.4	25.4	6	230	79.0			2.5	453	420			493	32.6	76.7	HH
28	610.1	661.5			354.9	1626.5		13846	14.3	30.8	6	230	83.0			2.2	440	416			507	42.0	76.2	LEO
29	527.7	564.5				1092.2		9514	14.2	41.7	6	230	71.7				433	396				54.6	75.7	LEO
30	521.8	544.2				1066.0		9136	14.4	47.6	6	230	65.7				426	380				51.3	76.7	LEO
31	[illegible]	179.9			95.2	[illegible]		[illegible]	14.3	30.4	6	230	66.5			2.7	450	413			446	38.1	76.2	LEO
20178.6 TOTAL		18210.2			1819.8	40145.3		339326	451.6	1215.8			2026.8			24.5	13799	11893			6758	1329.7	2408	
743.0 MAXIMUM		739.1			358.7	1703.1		14599	14.9	61.3			83.0			3.3	460	430			507	57.9	79.0	
420.0 MINIMUM		75.7			15.0	726.0		6412	14.0	25.4			50.5			2.2	410	380			410	35.5	74.6	LEO
648.9 AVERAGE		637.9			121.3	1295.1		10946	14.5	39.2	6	230	65.3			2.7	445	410			450	42.8	77.6	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY Richard D. [illegible] | DATE 1/2/91

APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 3967 REPLACES DA FORM ... WHICH WILL BE USED.

OM-10

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 136 | MONTH: JAN. 1991

DAY ↓	STEAM PRODUCED #1	#2	#3	#4	#5	TOTAL	FEED-WATER TO BOILER	FUEL USED LB. M.C.F. GAL.	EVAP. LB. PER UNIT	OUTSIDE TEMP. AV.	FEEDWATER HEATER PRESS.	TEMP.	MAKEUP GAL.	%O2 BOILER 1	2	#5	FLUE GAS TEMPERATURE BOILER 1	2	3	FLUE TEMP 4	FLUE TEMP 5	MAKE UP %	EFF.	INIT.
	1000 LB.	1000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.	1,000 LB.			°F.	LB.	°F.	X 1000				°F.	°F.	°F.					
		(1)	(2)	(3)	(4)	(5)	X (6)/666	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1	676.1	691.6			5.5	1373.2		11670	14.5	30.3	6	230	64.8			2.8	437	420			450	39.3	77.5	LEO
2	710.0	678.1			11.9	1400.0		11860	14.6	39.1	6	230	66.4			2.6	450	413			450	39.5	77.7	LEO
3	718.8	680.9			43.7	1443.4		12239	14.6	33.3	6	230	72.6			2.6	447	413			470	41.9	77.6	RH
4	693.5	679.0			95.3	1467.8		12527	14.5	32.8	6	230	76.2			2.7	453	420			455	43.2	77.1	RH
5	659.6	663.4				1323.0		11290	14.5	29.4	6	230	64.9				457	410				40.9	77.1	RH
6	595.5	609.2				1204.7		10245	14.5	38.5	6	230	62.2				450	400				43.0	77.4	RH
7	703.3	625.6		135.0	80.7	1544.6		13204	14.4	29.5	6	230	78.1			3.2	460	407		430	423	42.1	77.0	RH
8				1779.7		1779.7		14619	15.0	17.2	6	230	85.4							460		39.9	77.9	RH
9	374.4	338.6		783.4	131.0	1657.4		13971	14.6	27.9	6	230	75.3			2.7	460	415		450	462	37.8	77.8	RH
10	747.9	727.5			76.6	1553.0		13138	14.5	32.9	6	230	58.1			2.4	466	426			440	41.1	77.8	HH
11	742.1	727.5			364.3	1833.9		15432	14.6	16.3	6	230	60.0			5.5	467	427			510	37.2	77.8	HH
12	717.8	679.9			108.8	1506.5		12646	14.7	27.5	6	230	49.8				460	443			485	27.5	78.3	HH
13	765.3	699.4				1464.7		12206	14.7	26.5	6	230	50.0				465	430				28.4	78.4	HH
14	727.7	667.3			272.8	1667.8		14015	14.7	25.2	6	230	61.9				466	410			486	31.0	78.2	HH
15	656.7	688.7			70.3	1415.7		12244	14.3	30.7	6	230	57.4				457	420			445	34.9	76.2	HH
16	672.2	695.5			19.9	1387.6		11762	14.6	27.9	6	220	57.0				457	427			470	34.2	77.8	HH
17	636.4	656.6				1293.0		10937	14.6	41.1	6	230	56.1				447	403				36.1	77.8	PK
18	718.7	678.0				1396.8		11824	14.6	37.2	6	230	58.0				467	430				34.5	77.8	PK
19	677.0	634.3				1311.4		11138	14.5	36.6	6	230	56.4				460	413				35.8	77.8	PK
20	608.2	567.4				1175.6		9858	14.7	42.0	6	230	49.2				458	400				34.8	78.5	PK
21	497.6	448.2		521.4		1467.2		12437	14.5	15.0	6	230	57.2				460	410		430		32.4	77.6	PK
22				1917.1		1917.1		15602	15.2	11.0	6	230	73.1							489		31.8	80.9	PK
23				1829.8		1829.8		14802	15.2	23.6	6	230	72.7							491		33.0	81.3	PK
24	386.1	362.8		697.2	112.6	1558.7		13612	14.1	31.5	6	230	76.8				490	420		490	480	41.0	75.1	JH
25	682.9	712.9			386.5	1782.3		14825	14.9	17.2	6	230	57.4				466	423			486	26.8	79.2	JH
26	673.2	673.2			376.3	1722.7		14466	14.6	22.6	6	230	58.7				450	430			520	28.3	77.8	JH
27	726.5	722.7			139.7	1588.9		13315	14.7	34.0	6	230	54.2				456	410			505	28.4	75.3	JH
28	684.8	655.7				1340.5		11295	14.6	40.7	6	230	53.6				470	423				36.4	77.8	JH
29	682.9	688.7				1371.6		11501	14.7	38.0	6	230	45.9				460	423				27.9	78.5	JH
30	675.1	608.2				1283.3		10780	14.7	40.0	6	230	50.4				460	407				32.7	78.4	JH
31	700.3	692.6			113.5	1506.4		12596	14.8	30.0	6	230	51.5				461	410			465	38.4	78.9	RH
	18505.7	17983.6		7663.6	2410.4	46563.3		392146	453.7	942.4	6	230	1918.3			27.5	12546	11683		3241	[illegible]	1040.2	2418.8	
	765.3	727.5		1917.1	386.5	1917.1		15602	15.2	42.0	6	230	85.4			3.2	492	443		491	520	43.2	81.3	
	374.4	362.8		135.0	5.5	1204.7		9858	14.1	11.0	6	220	45.9			5.4	437	477		430	423	26.8	76.2	
	660.9	642.2		1094.8	141.7	1502.0		12650	14.6	30.4	6	230	61.8			3.4	458	417		462	470	33.6	78.0	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY: Richard D. Brand | DATE: 2/6/91

APPROVED BY | DATE

POST ENGINEER | DATE

DA FORM 3987

OM-11

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 136 | MONTH: FEB 1991

DAY	#1 STEAM PRODUCED 1000 LB.	#2 STEAM PRODUCED 1000 LB. (1)	#3 1,000 LB. (2)	#4 1,000 LB. (3)	#5 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. X (6)/666	FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	FEEDWATER HEATER MAKEUP GAL. X 1000 (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	BOILER 2 °F. (17)	BOILER 3 °F. (18)	FLUE TEMP 4 (19)	FLUE TEMP 5 (20)	MAKE UP % (21)	EFF. (22)	INIT. (23)
1	1,69.4	621.7			327.3	1648.4		13815	14.7	26.1	6	230	51.1				470	410			490	27.2	78.3	RH
2	1,26.6	603.3			25.1	1255.0		10608	14.6	37.8	6	230	48.2				453	400			[illegible]	31.9	77.9	RH
3	523.7	383.1			111.6	1118.4		9117	15.1	42.1	6	230	45.2				455	496			488	33.6	80.5	RH
4	677.1	419.0			209.3	1305.4		11031	14.6	45.7	6	230	41.6				456	416			453	29.7	77.8	RH
5	626.6	134.4				1261.0		10500	14.8	48.4	6	230	41.5				460	410				32.7	79.1	PH
6	615.0	603.3				1218.3		10224	14.7	50.0	6	230	46.5				457	413				31.8	78.4	RH
7	726.5	662.5				1379.0		11503	14.9	43.8	6	230	45.6				470	427				27.3	79.5	LH
8	679.9	666.4				1344.3		11252	14.8	42.3	6	230	48.6				466	412				30.1	78.8	LH
9	653.8	641.1				1394.9		10204	14.8	43.3	6	230	40.3				462	417				25.9	78.9	LH
10	715.0	651.8				1367.7		11405	14.8	41.0	6	230	48.1				467	412				29.3	78.9	LH
11	717.7	692.6			200.7	1613.0		13576	14.7	28.7	6	230	52.6				[illegible]	426	440		440	27.2	78.2	HH
12	615.9	520.9	509.9		262.7	1909.3		15038	15.7	19.9	6	230	58.3				480	440			520	25.4	82.1	HH
13	587.7	662.5			296.1	1646.3		13714	14.3	24.8	6	230	54.1				465	412			552	27.2	78.9	HH
14	711.9	688.7			113.8	1514.4		12454	15.0	37.4	6	230	52.3				470	420			470	28.7	79.9	PK
15	761.5	698.4			81.4	1541.3		12946	14.7	33.5	6	230	48.1				470	423			480	25.9	78.3	PK
16	256.1	233.8		1207.1	206.7	1903.7		15764	14.9	16.7	6	230	57.1				470	420		480	510	26.8	79.5	PK
17				1708.7		1708.7		14069	14.9	32.2	6	230	59.3							507		28.9	79.4	PK
18				1614.4		1614.4		13336	14.9	32.0	6	230	55.0							480		28.4	79.4	PK
19				1661.0		1661.0		13740	14.9	41.5	6	230	62.8							495		31.5	78.3	PK
21	2609	2435	54.7	831.1		1390.2		11475	14.9	45.3	6	230	59.8				460	410	437	470		35.8	79.4	PK
21	706.2	656.7			4.9	1367.8		11389	14.8	44.0	6	230	46.8				463	443			440	28.5	78.9	JH
22	644.9	645.0			46.9	1341.8		11188	14.8	44.7	6	230	45.2				466	440			460	28.0	78.9	JH
23	695.5	643.1			299.8	1638.4		13733	14.7	24.0	6	230	51.7				470	433			487	26.2	78.3	JH
24	704.2	680.9			220.9	1606.0		13527	14.6	31.0	6	230	49.8				476	450			525	25.8	77.8	JH
25	742.0	682.9			143.0	1567.9		13169	14.6	34.0	6	230	51.9				473	450			460	27.5	77.8	JH
26	744.0	609.1	209.5		72.7	1635.3		13013	15.5	33.1	6	230	51.2				480	450	450		480	26.1	82.7	JH
27	433.6	379.3	623.9			1436.8		12224	14.5	32.9	6	230	51.2				480	455	416			29.7	77.4	JH
28			1168.6		303.1	1471.7		11741	15.5	37.7	6	230	51.8						446		533	29.3	82.6	RH
29																								
30																								
31																								
TOTAL	15333.6	13924.0	2566.5	7022.3	2926.0	41772.4		346357	416.2	1023.8	6	230	1428.7				11211	10288	2219	2432	8359	804.5	2215.9	
MAX	761.5	698.4	1168.6	1708.7	327.3	1903.7		15764	15.7	50.0	6	232	62.8				480	498	480	507	553	35.8	82.7	
MIN	256.1	233.8	54.7	831.1	4.9	1118.4		9117	14.5	16.7	6	232	40.3				453	410	416	470	440	25.4	77.4	
AVG.	638.9	580.2	513.3	1404.5	172.1	1491.9		12369	14.9	36.6	6	232	51.0				467	429	444	496	492	28.7	79.1	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

PREPARED BY R. D. Drauck | DATE 3/4/91 | APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 2007

OM-12

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)
For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 136 | MONTH: MARCH 91

Day	Steam Produced #1 1000 LB.	#2 1000 LB. (1)	#3 1,000 LB. (2)	#4 1,000 LB. (3)	#5 1,000 LB. (4)	Total 1,000 LB. (5)	Feed-water to Boiler 1,000 LB. X (6)/666	Fuel Used LB. M.C.F. GAL. (7)	Evap. LB. per Unit (8)	Outside Temp. Av. °F. (9)	Feedwater Heater Press. LB. (10)	Feedwater Heater Temp. °F. (11)	Feedwater Heater Makeup Gal. X 1000 (12)	%O2 Boiler 1 (13)	%O2 Boiler 2 (14)	%O2 Boiler 3 (15)	Flue Gas Temperature Boiler 1 °F. (16)	Boiler 2 °F. (17)	Boiler 3 °F. (18)	Flue Temp 4 (19)	Flue Temp 5 (20)	Make Up % (21)	Eff. (22)	Init. (23)
1			947.5		1487	1096.2		8641	15.7	50.9	6	230	460						410		505	34.9	83.7	RH
2			805.5		[illegible]	805.5		6387	15.6	59.3	6	230	402						383			41.6	83.0	Pm
3			898.6			898.6		7143	15.5	46.7	6	230	37.1						390			34.4	82.6	RH
4			1151.2		79.5	1230.7		9656	15.7	41.3	6	230	40.1						413		440	27.1	83.7	RH
5			1183.7		274.1	1357.8		10624	15.8	38.9	6	230	41.8						417		500	25.6	84.1	RH
6			1112.7		172.2	1284.9		10056	15.8	46.3	6	230	46.9						417		503	30.4	84.1	RH
7	28.1		1045.3		231.0	1304.4		10528	15.3	43.6	6	230	52.2				400		413		560	33.3	81.6	HH
8	572.3		1073.2			1645.5		13351	15.2	28.9	6	230	57.1				440		417			28.9	81.1	HH
9	387.1		1002.2		165.0	1394.3		11213	15.4	31.7	6	230	48.9				440		400		535	29.2	81.9	HH
10	31.0		1019.6		200.9	1351.5		10664	15.6	31.4	6	220	44.5				390		403		517	27.4	83.4	HH
11	617.9		967.2			1585.1		12802	15.3	30.3	6	230	55.9				440		493			29.4	81.5	HH
12	524.8		950.9			1475.7		11987	15.2	36.0	6	230	52.9				420		420			29.8	81.0	HH
13	373.4		944.0		77.2	1394.6		11239	15.3	38.9	6	230	52.8				440		410		500	31.5	81.6	HH
14			1036.0		322.0	1398.0		11123	15.5	39.0	6	230	48.8						400		540	29.0	82.6	PK
15			1039.5		370.1	1409.6		11160	15.6	39.3	6	230	46.0						403		560	27.1	83.2	PK
16			1058.1		172.9	1231.0		9682	15.7	43.8	6	230	38.6						406		513	26.1	83.7	PK
17			1022.1		104.3	1126.4		9845	15.5	46.0	6	230	37.2						400		530	27.5	82.6	PK
18			975.4		261.0	1236.4		9723	15.7	46.1	6	230	43.9						400		490	27.5	83.7	PK
19	282.2	125.1	597.0		256.0	1260.3		10369	14.7	47.4	6	230	46.8				470	400	390		550	31.5	78.4	PK
20	642.1	601.4				1243.5		10586	14.5	44.7	6	230	45.0				460	430				30.1	77.3	PK
21	527.7	493.7	281.7		85.2	1388.3		11640	14.7	38.8	6	230	46.7				465	440	380		490	28.0	78.3	JH
22			1025.5		371.4	1396.9		10966	15.7	38.7	6	230	48.3						410		530	28.8	83.7	JH
23			1036.0		229.5	1265.5		9902	15.7	40.4	6	230	38.3						403		483	25.0	83.7	JH
24			1036.0		164.7	1200.7		9298	15.8	43.3	6	230	42.1						410		458	29.2	84.1	JH
25			998.7		290.9	1289.6		10203	15.6	46.3	6	230	51.2						413		463	33.0	83.1	JH
26			991.7		211.6	1203.3		9494	15.6	49.6	6	230	44.5						400		467	30.8	82.4	JH
27			1075.5		12.6	1088.1		8474	15.9	52.9	6	230	40.7						395		440	31.2	84.5	JH
28			811.3			811.3		6260	16.0	58.6	6	230	40.6						382			41.6	85.3	RH
29			1039.3		32.2	1071.5		8419	15.7	46.8	6	230	42.0						413		460	32.6	83.8	RH
30			1132.3		46.3	1178.6		9189	15.8	38.5	6	230	45.5						427		510	32.1	84.4	RH
31			1074.3		41.9	1115.2		8713	15.8	40.2	6	230	40.9						423		420	29.5	84.3	RH
Total	3886.6	1220.2	29238.0		4394.2	38739.0		309436	480.9	1324.6	186	7130	1403.5				4365	1270	12246		12014	944.1	2563.4	
Max	617.9	601.4	1151.2		371.4	1645.5		13351	16.0	59.3	6	230	57.1				470	440	493		560	41.6	85.3	
Min	28.1	125.1	281.7		12.6	805.5		6387	14.5	28.9	6	230	37.1				390	400	380		440	25.0	77.3	
Avg	388.7	406.7	974.6		183.1	1249.6		9982	15.5	42.7	6	230	45.3				437	423	408		501	30.5	82.7	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS
O2 Analyzers out of order

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

DA FORM 2867

OM-13

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 136 | MONTH: APRIL 91

DAY ↓	STEAM PRODUCED #1 1000 LB.	#2 1000 LB. (1)	#3 1,000 LB. (2)	#4 1,000 LB. (3)	#5 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. X (6)/666	FUEL USED LB. M.C.F. GAL. (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	TEMP. °F. (11)	MAKEUP GAL. X 1000 (12)	% O2 BOILER 5 (13)	BOILER 2 (14)	BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	2 °F. (17)	3 °F. (18)	FLUE TEMP 4 (19)	FLUE TEMP 5 (20)	MAKE UP % (21)	EFF. (22)	INIT. (23)
1			1104.6		66.5	1171.1		8977	16.1	43.8	6	230	44.3	Out		Out			410		485	31.5	85.8	RH
2			1137.2		50.4	1187.6		9144	16.0	45.6	6	230	42.9	of		of			413		510	29.7	85.5	RH
3			1115.1		73.8	1188.9		9257	15.9	46.3	6	230	46.9	order		order			420		480	32.9	84.6	RH
4			876.5		47.4	923.9		7733	14.8	53.8	6	230	45.9						410		460	41.4	78.7	HH
5			704.2			704.2		5900	14.7	61.7	6	230	42.4						377			50.3	78.6	HH
6			562.2		3.5	565.7		4832	14.5	63.7	6	230	35.4			5.2			360		480	52.1	77.1	HH
7			521.4			521.4		4511	14.3	72.9	6	230	33.2			4.9			373			53.0	76.1	HH
8			607.6			607.6		5106	14.7	71.6	6	230	39.9			4.4			358			54.7	78.3	HH
9			622.7			622.7		5223	14.7	70.0	6	230	37.6			3.7			377			50.2	78.3	HH
10			692.5			692.5		5746	14.9	59.0	6	230	39.3			3.5			376			47.2	79.4	HH
11			1031.3			1031.3		8223	15.5	45.6	6	230	41.2			2.8			406			33.2	82.6	PK
12			1067.2			1067.2		8549	15.4	45.5	6	230	44.1			4.1			408			34.4	82.1	PK
13			1051.0			1051.0		8336	15.6	47.2	6	230	41.4			4.7			413			32.8	83.2	RH
14			948.6			948.6		7478	15.6	49.6	6	230	37.5			4.2			403			32.9	83.2	PK
15			1106.9			1106.9		8755	15.6	50.0	6	230	46.4			4.7			420			34.9	83.2	RH
16			861.3			861.3		6831	15.5	58.9	6	230	46.0			4.6			403			44.4	82.6	PK
17			873.0			873.0		6927	15.6	54.0	6	230	48.2			4.4			403			41.2	83.1	PK
18			1048.8			1048.8		8421	15.3	51.6	6	230	40.9			4.6			421			40.9	81.5	JH
19			878.8			878.8		7017	15.4	54.1	6	230	54.2			4.7			410			51.3	82.1	JH
21			741.5			741.5		5960	15.3	54.8	6	230	43.1			4.4			385			48.4	81.5	JH
21			829.9			829.9		6622	15.4	45.3	6	230	42.1			4.4			388			42.2	82.1	JH
22			1144.2			1144.2		9017	15.7	47.9	6	230	46.0			4.8			432			33.4	83.5	JH
23			919.6			919.6		7280	15.6	57.1	6	230	44.5			4.6			410			40.3	83.2	JH
24			792.7			792.7		6363	15.4	57.0	6	230	47.2			4.2			784			49.6	82.0	JH
25			725.1			725.1		5848	15.3	60.1	6	230	49.7			4.4			375			57.1	81.6	RH
26			736.8			736.8		5954	15.3	60.9	6	230	49.0			4.7			377			55.3	81.6	RH
27			612.2			612.2		5084	14.9	66.8	6	230	51.0			4.7			366			69.3	79.4	RH
28			641.3			641.3		5249	15.1	61.8	6	230	52.3			4.7			373			67.9	80.5	RH
29			704.2			704.2		5717	15.2	60.6	6	230	50.5			4.5			340			59.7	81.0	RH
30			715.8			715.8		5808	15.2	58.6	6	230	50.4			4.5			377			58.6	81.1	RH
31																								
TOTAL			25374.2		241.6	25615.9		205867	458.5	1675.8	180	6900	1328.0			110.4			11788		2415	1370.7	2443.5	
MAXIMUM			1144.2		73.8	1188.9		9257	16.1	72.9	6	230	54.2			5.2			420		510	69.3	85.8	
MINIMUM			521.4		3.5	521.4		4511	14.3	43.8	6	230	33.2			2.8			358		460	29.7	76.1	
AVERAGE			845.8		48.3	853.9		6862	15.3	55.9	6	230	44.3			4.4			393		483	45.7	81.5	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

SEE REVERSE SIDE FOR INSTRUCTIONS

OWI-14

CA COPY

FACILITIES ENGINEERING OPERATING LOG (Boiler Plant)

For use of this form, see AR 420-49; the proponent agency is USACE.

INSTALLATION: WATERVLIET ARSENAL | PLANT: BOILER PLANT | BLDG. NO.: 136 | MONTH: MAY 91

DAY	STEAM PRODUCED #1 1000 LB.	#2 1000 LB. (1)	#3 1,000 LB. (2)	#4 1,000 LB. (3)	#5 1,000 LB. (4)	TOTAL 1,000 LB. (5)	FEED-WATER TO BOILER 1,000 LB. X (6)/666	#6 OIL FUEL USED GAL. (7)	EVAP. LB. PER UNIT (8)	OUTSIDE TEMP. AV. °F. (9)	FEEDWATER HEATER PRESS. LB. (10)	FEEDWATER HEATER TEMP. °F. (11)	FEEDWATER HEATER MAKEUP GAL. X 1000 (12)	%CO2 BOILER 1 (13)	%CO2 BOILER 2 (14)	%CO2 BOILER 3 (15)	FLUE GAS TEMPERATURE BOILER 1 °F. (16)	FLUE GAS TEMPERATURE BOILER 2 °F. (17)	FLUE GAS TEMPERATURE BOILER 3 °F. (18)	FLUE TEMP 4 (19)	FLUE TEMP 5 (20)	MAKE UP % (21)	EFF. (22)	INIT. (23)
1			612.2			612.2		5049	15.0	66.8	6	230	46.3			4.3			367			63.0	79.8	RH
2			770.5			770.5		6251	14.1	56.6	6	230	49.9			4.8			380			53.9	75.1	HH
3			903.2			903.2		7411	15.0	52.4	6	230	53.3			4.9			398			49.2	80.2	HH
4			576.1			576.1		4701	15.1	57.2	6	230	40.3			4.3			359			58.2	80.7	HH
5			569.1			569.1		4714	14.9	59.9	6	230	37.8			4.3			356			55.3	79.5	HH
6			644.8			644.8		5330	14.9	61.4	6	230	44.6			4.3			368			57.6	79.6	HH
7			635.5			635.5		5210	15.0	59.6	6	230	43.9			4.6			371			52.5	79.9	HH
8			663.4			663.4		5438	15.1	58.8	6	230	44.9			4.5			368			56.3	80.3	HH
9			692.5			692.5		5630	15.2	57.6	6	230	43.5			4.3			373			52.3	81.0	PK
10			290.0			290.0		2376	15.1	57.6	6	230	21.3			3.3			368			61.2	80.3	PK
11	MAIN plant shut down 5-10-91 @ 1100 hrs.																							
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31																								
TOTAL			6357.3			6573.3		52610	149.4	587.3	60	2300	425.8			43.5			3708			564.5	796.4	
MAX			903.2			903.2		7411	15.2	66.8	6	230	53.3			4.9			398			63.0	81.0	
MIN			290.0			290.0		2376	14.1	52.4	6	230	21.3			3.3			356			49.2	75.1	
AVG.			635.7			635.7		5261	14.9	58.7	6	230	42.6			4.4			371			56.5	79.6	

EVAPORATION LB. STEAM PER LB. STD. FUEL

FUEL USED DURING MONTH (STANDARD TONS)

REMARKS

SEE REVERSE SIDE FOR INSTRUCTIONS

PREPARED BY | DATE | APPROVED BY | DATE | POST ENGINEER | DATE

DA FORM 2007

ECIP 1--HIGH-EFFICIENCY LIGHTING

RS&H®

SUBJECT ECIP # 1
LAMPS / BALLASTS
DESIGNER C. Warren
CHECKER

AEP NO 290-0379-002
SHEET 1 OF 1
DATE 4/1/92
DATE

SAVINGS CALCULATIONS

FROM ECO PROJECTS

ECO #	ANNUAL ELECT SAVINGS (MBtu/yr)	DIFFERENTIAL LAMP REPL COSTS ($/yr)	REBATE AMT. ($)
8C	117	96	2203
8D	589	809	3138
8H	4478	2530	64979
TOTAL	5,184	3,435	70,320

04/01/92

ECO Construction Cost Estimate
Calculations

ECO Name: Energy Efficient Fluorescent Lights & Ballasts

ECO #: ECIP 1

1991 ECO "bare" costs (from cost estimate sheet)	
Material	$151,780
Labor	$114,206
Subtotal bare costs	$265,986
FICA Insurance (20% of Labor)	$22,841
Sales Tax (not applicable for GOGO)	$0
Subtotal	$288,827
Overhead (15%)	$43,324
Subtotal	$332,151
Profit (10%)	$33,215
Subtotal	$365,366
Bond (1%)	$3,654
Subtotal	$369,020
Contingency (10%)	$36,902
Subtotal (Construction Cost Input For LCCID *)	$405,922
SIOH (6% of Construction Cost)	$24,355
Subtotal	$430,277
Design (6% of Construction Cost)	$24,355
Total Project Cost	$454,632

* The SIOH costs (6.0%) and Design costs (6.0%) are automatically added in the Life Cycle Cost In Design (LCCID) analysis program.

CONSTRUCTION COST ESTIMATE

DATE PREPARED

SHEET / OF /

PROJECT: ENERGY ENGINEERING ANALYSIS

LOCATION: WVA

ARCHITECT ENGINEER: REYNOLDS, SMITH AND HILLS A.E.P., INC.

BASIS FOR ESTIMATE
- ☐ CODE A (No design completed)
- ☒ CODE B (Preliminary design)
- ☐ CODE C (Final design)
- ☐ OTHER (Specify)

DRAWING NO.

ESTIMATOR: C. WARREN

CHECKED BY: P. HUTCHINS

ECIP 1 SUMMARY	QUANTITY NO. UNITS	UNIT MEAS.	LABOR PER UNIT	LABOR TOTAL	MATERIAL PER UNIT	MATERIAL TOTAL	TOTAL COST
ECO 8C — PROD. AREAS							
32 W LAMPS (T-8)	308	EA	2.25	693	2.10	647	1340
ELECTRONIC BALLASTS	102	EA	21.00	2,142	29.33	2992	5134
ECO 8D - NON-PROD.							
34 W LAMPS	7845	EA	2.25	17,651	1.80	14,121	31772
ECO 8H - PROD AREAS							
60 W LAMPS	6248	EA	2.50	15,620	3.95	24,680	40,300
ELECTRONIC BLSTS	3124	EA	25.00	78,100	35.00	109,340	187,440
				114,206		151,780	265,986
CALCULATIONS FOR ECIP							
FICA (20%)							

ENG FORM 150
1 AUG 59

(ER 1110-345-730)) PREVIOUS EDITION MAY BE USED (TRANSLUCENT)

* U.S. GOVERNMENT PRINTING OFFICE . 1959 O—510148

ECIP 1 - HIGH EFFICIENCY LIGHTING

ECIP COST ESTIMATE CALCULATIONS

	#	LABOR	MATERIAL	
32W T8 LAMPS	308	$693	$647	
FICA (20% LAB)		$139		
SUBTOTAL		$832	$647	
OVERHEAD (15%)		$125	$97	
SUBTOTAL		$956	$744	
PROFIT (10%)		$96	$74	
SUBTOTAL		$1,052	$818	
BOND (1%)		$11	$8	
SUBTOTAL		$1,062	$827	
PER UNIT		$3.45	$2.68	$6.13

	#	LABOR	MATERIAL	
32W T8 BALLASTS	102	$2,142	$2,992	
FICA (20% LAB)		$428		
SUBTOTAL		$2,570	$2,992	
OVERHEAD (15%)		$386	$449	
SUBTOTAL		$2,956	$3,441	
PROFIT (10%)		$296	$344	
SUBTOTAL		$3,252	$3,785	
BOND (1%)		$33	$38	
SUBTOTAL		$3,284	$3,823	
PER UNIT		$32.20	$37.48	$69.67

	#	LABOR	MATERIAL	
34W LAMPS	7845	$17,651	$14,121	
FICA (20% LAB)		$3,530		
SUBTOTAL		$21,181	$14,121	
OVERHEAD (15%)		$3,177	$2,118	
SUBTOTAL		$24,358	$16,239	
PROFIT (10%)		$2,436	$1,624	
SUBTOTAL		$26,794	$17,863	
BOND (1%)		$268	$179	
SUBTOTAL		$27,062	$18,042	
PER UNIT		$3.45	$2.30	$5.75

	#	LABOR	MATERIAL	
60W LAMPS	6248	$15,620	$24,680	
FICA (20% LAB)		$3,124		
SUBTOTAL		$18,744	$24,680	
OVERHEAD (15%)		$2,812	$3,702	
SUBTOTAL		$21,556	$28,382	
PROFIT (10%)		$2,156	$2,838	
SUBTOTAL		$23,711	$31,220	
BOND (1%)		$237	$312	
SUBTOTAL		$23,948	$31,532	
PER UNIT		$3.83	$5.05	$8.88

	#	LABOR	MATERIAL	
60W LAMP BALLASTS	3124	$78,100	$109,340	
FICA (20% LAB)		$15,620		
SUBTOTAL		$93,720	$109,340	
OVERHEAD (15%)		$14,058	$16,401	
SUBTOTAL		$107,778	$125,741	
PROFIT (10%)		$10,778	$12,574	
SUBTOTAL		$118,556	$138,315	
BOND (1%)		$1,186	$1,383	
SUBTOTAL		$119,741	$139,698	
PER UNIT		$38.33	$44.72	$83.05

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FORM 1391 - COST ESTIMATE

32W LAMPS	308	$6.13	2	1,889	1,889	308	2.25	693	2.10	647
ELECT. BALL	102	$69.67	7	7,107	7,107	102	21.00	2,142	29.33	2,992
34W LAMPS	7845	$5.75	45	55,481	45,104	7845	2.25	17,651	1.80	14,121
60W LAMPS	6248	$8.88	56	45,104	55,481	6248	2.50	15,620	3.95	24,680
EL BALL	3124	$83.05	259	259,440	259,440	3124	25.00	78,100	35.00	109,340
SUB			369		369,020			114,206		151,779
CONT (10%)			37		36,902					
TOT CONTRACT			406		405,922					
SIOH (6%)			24		24,355					
TOTAL REQUEST			430		430,277					

ENERGY PLAN

ENERGY PLAN CALCULATIONS

	ELC	FSD	NAG	FSR	TOT	ACTUAL
FY91	182,203	2,002	84,527	302,279	571,011	571,011
ECO6	0	0	3,205	2,255	5,460	
ECO12	2,497	0	(3,122)	0	(625)	
ECO4	2,707	0	0	21,650	24,357	
ECO7	814	0	0	0	814	
ECO2	0	0	-278000	278000	0	
ECO10	1,901	0	0	0	1,901	
	7,919	0	(277,917)	301,905	31,907	
FY93	174,284	2,002	362,444	0	538,730	538,730
ECO8	5,184	0	0	0	5,184	
ECO15	0	0	9,851	0	9,851	
	5,184	0	9,851	0	15,035	
FY96	169,100	2,002	352,593	0	523,695	523,695

FY91	$3,669,678	$354,893	$54,282	$1,998,073	$6,076,926	$6,024,000
EC05	$151,000	$0	$0	$0	$151,000	$151,000
FY92	$3,518,678	$354,893	$54,282	$1,328,382	$5,256,235	$5,203,309
EC06	$0	$0	$13,333	$9,922	$23,255	$23,300
EC012	$50,814	$0	($12,988)	$0	$37,826	$37,900
EC04	$55,087	$0	$0	$95,260	$150,347	$141,900
EC07	$16,565	$0	$0	$0	$16,565	$15,600
EC02	$0	$0	($1,156,480)	$1,223,200	$66,720	$66,720
EC010	$38,685	$0	$0	$0	$38,685	$33,000
	$161,152	$0	($1,156,135)	$1,328,382	$333,399	$318,420
FY93	$3,357,526	$354,893	$1,210,417	$0	$4,922,836	$4,884,889
EC08	$105,494	$0	$0	$0	$105,494	$104,900
EC015	$0	$0	$40,980	$0	$40,980	$44,400
	$105,494	$0	$40,980	$0	$146,475	$149,300
FY96	$3,252,032	$354,893	$1,169,437	$0	$4,776,362	$4,735,589
				REDUCTIONS	(MBTU)	47,316
					($)	$1,288,411

	ELC	FSD	NAG	FSR	TOT	971691
FY91	182,203	2,002	84,527	302,279	571,011	
FY92	182,203	2,002	84,527	302,279	571,011	
FY93	174,284	2,002	362,444	0	538,730	
FY94	174,284	2,002	362,444	0	538,730	
FY95	174,284	2,002	362,444	0	538,730	
FY96	169,100	2,002	352,593	0	523,695	47,316

FY91	$3,637,718	$351,802	$53,809	$1,980,671	$6,024,000	
FY92	$3,486,718	$351,802	$53,809	$1,328,382	$5,220,711	
FY93	$3,331,645	$352,157	$1,201,086	$0	$4,884,889	
FY94	$3,331,645	$352,157	$1,201,086	$0	$4,884,889	
FY95	$3,331,645	$352,157	$1,201,086	$0	$4,884,889	
FY96	$3,224,272	$351,864	$1,159,454	$0	$4,735,589	$1,288,411

WATERVLIET ARSENAL
ENVIRONMENTAL IMPACT OF ENERGY SAVING PROJECTS

ENVIR.WQ1

EMISSIONS IN LBS PER MBTU

		#6 FUEL OIL				
EMISSION	COAL	0.5%	1%	2%	NGAS	BACT
SO2	1.8	0.54	1.08	2.36	0	0
NOx	0.061	0.36	0.29	0.36	0.25	0.04
Particulates	0.15	0.06	0.09	0.17	0.003	0.0002
CO2	209	169	169	169	110	110

EMISSIONS IN LBS PER KWH

		#6 FUEL OIL				
EMISSION	COAL	0.5%	1%	2%	NGAS	BACT
SO2	0.019	0.006	0.012	0.025	0	0
NOx	0.001	0.004	0.003	0.004	0.003	0.0004
Particulates	0.002	0.001	0.001	0.002	3E-05	2E-06
CO2	2.23	1.80	1.80	1.80	1.17	1.17

Source : Strategic Planning for Energy and the Environment,
Winter 1990-1991, p. 57
Environmental Costs of Electricity, DOE & New York State
Energy Research and Development Authority

EMISSIONS IN LBS PER MBTU

EMISSION	NGAS	COAL	OIL
CO2	115	200	170
SO2	0.0005	2.67	0.95
NOx	0.39	1.12	0.48
CO	20	30	30
Hydrocarbons	3	10	5
Particulates	10	230	2540

Source : American Gas Association, Edison Electric Institute

WATERVLIET ARSENAL
ENVIRONMENTAL AFFECTS OF ENERGY SAVING PROJECTS

NIAGRA-MOHAWK EMISSIONS ESTIMATE

Fuel Type	Percent	Emissions (lbs/kwh)			
		SO2	NOX	Part.	CO2
Coal	42	0.019	0.001	0.002	2.23
Natural Gas	10	0	0.003	3E-05	1.17
Residual Oil	34	0.012	0.003	0.001	1.8
Nuclear	14	-	-	-	-
Hydro	-	-	-	-	-
Net Total		0.012	0.002	0.001	1.666

RS&H®

SUBJECT Environmental Impact of Projects

AEP NO

SHEET ______ OF ______

DESIGNER P. Hutchins

DATE

CHECKER

DATE

Niagra Mohawk Generation Fuel Mix

1990

	GWH	%
Coal	8678	42
Nat Gas	1950	10
Res. Oil	7109	34
Nuclear	2975	14
Hydro	55	-
	20,767	100

OS-64

State of New York
Department of Public Service
Office Services Unit
Three Empire State Plaza
Albany, NY 12223

TELECOPY COVER PAGE

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EP-6

TABLE VI-1
FUEL REQUIREMENTS - HISTORICAL - Coal & Natural Gas

	COAL					NATURAL GAS				
	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
Installed Gen. Cap. (MW)										
New York Power Pool	3973	4763	4770	4807	4800	833	682	894	896	957
Central Hudson	-	366	366	370	370	151	-	62	72	136
Con Edison	-	-	-	-	-	30	30	30	30	30
LILCO	-	-	-	-	-	-	-	-	-	-
NYSEG	2366	2386	2405	2414	2414	-	-	-	-	-
Niagara Mohawk	1270	1275	1275	1295	1294	637	637	712	705	686
Orange & Rockland	-	399	387	391	385	-	-	75	74	90
RG&E	337	337	337	337	337	15	15	15	15	15
NYPA	-	-	-	-	-	-	-	-	-	-
Fuel Consumption(2)(6) Thousands of Tons Millions of Cubic Feet										
New York Power Pool	8316	9939	11166	12269	12076	131450	173393	147030	180444	223798
Central Hudson	-	414	884	889	818	258	6037	2179	4810	6240
Con Edison	-	-	-	-	-	78799	84627	81426	91576	119046
LILCO	-	-	-	-	-	25339	28774	28087	25669	35243
NYSEG	5327	5955	610[illegible]	6467	6403	-	-	-	-	-
Niagara Mohawk	2462	2805	305[illegible]	3499	3420	2096	19514	11869	27089	22560
Orange & Rockland	-	145	453	588	665	15897	14813	12018	12332	16717
RG&E	527	620	665	826	770	26	47	4	727	293
NYPA	-	-	-	-	-	9035	19581	11447	18241	23699
Generation (GWH)(1)(5)										
New York Power Pool	20652	25204	28523	31026	30679	12459	16392	14103	17220	21570
Central Hudson	-	1087	2281	2292	2202	20	522	174	405	577
Con Edison	-	-	-	-	-	7499	8190	8022	8889	11732
LILCO	-	-	-	-	-	2308	2650	2534	2352	3303
NYSEG	13196	15025	15588	16345	16211	-	-	-	-	-
Niagara Mohawk	6140	7185	7894	9013	8678	177	1785	1070	2456	1950
Orange & Rockland	-	347	1090	1263	1612	1576	1385	1172	1315	1614
RG&E	1316	1560	1670	2113	1976	1	3	-	41	19
NYPA	-	-	-	-	-	878	1857	1131	1762	2375
Fuel Cost Cents per Million BTU										
Central Hudson	-	190	192	192	204	438	312	232	278	279
Con Edison	-	-	-	-	-	253	303	246	263	282
LILCO	-	-	-	-	-	228	256	231	249	230
NYSEG	166	157	153	156	165	-	-	-	-	-
Niagara Mohawk	178	157	155	153	157	387	217	215	251	249
Orange & Rockland	-	195	201	211	216	222	232	236	270	273
RG&E	173	167	163	154	156	390	342	408	269	302
NYPA	-	-	-	-	-	214	258	230	247	277

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TABLE VI-1
FUEL REQUIREMENTS - HISTORICAL - Residual Oil & Distillate Oil

	RESIDUAL OIL					DISTILLATE OIL				
	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
Installed Gen. Cap. (MW)										
New York Power Pool	13896	13265	13431	13343	13298	3470	3490	3445	3685	3448
Central Hudson	895	546	480	480	537	43	43	38	38	43
Con Edison	6138	6173	6323	6323	6227	2046	2046	2046	2037	2037
LILCO	2693	2730	2731	2718	2730	1049	1069	1103	1359	1347
NYSEG	-	-	-	-	-	7	7	7	7	7
Niagara Mohawk	2262	2272	2361	2286	2286	237	237	237	230	-
Orange & Rockland	902	507	507	507	489	74	74	-	-	-
RG&E	173	204	204	204	204	14	14	14	14	14
NYPA	833	833	825	825	825	-	-	-	-	-
Fuel Consumption Thousands of BBLS(2)(6)										
New York Power Pool	52346	50943	63495	64714	53355	1111	1206	1946	3499	905
Central Hudson	5989	3596	3645	3892	3396	4	7	8	29	8
Con Edison	17631	18047	23474	27633	19225	359	508	827	1551	224
LILCO	14842	17897	18828	18614	15730	738	683	1099	1866	670
NYSEG	-	-	-	-	-	1	1	1	1	0
Niagara Mohawk	9613	7159	11975	10406	11554	7	3	5	7	-
Orange & Rockland	2200	1742	1948	2087	912	-	-	-	-	-
RG&E	312	569	920	789	898	2	4	6	45	3
NYPA	1759	1933	2705	1293	1640	-	-	-	-	-
Generation (GWH)										
New York Power Pool	31533	30946	38978	39704	32630	447	486	781	1420	357
Central Hudson	3769	2283	2341	2533	2200	1	3	7	12	1
Con Edison	10208	10582	14225	16083	11579	127	177	299	581	78
LILCO	9083	11293	11584	11287	9660	315	304	471	810	277
NYSEG	-	-	-	-	-	-	-	-	-	-
Niagara Mohawk	5809	4254	7442	6468	7109	3	1	2	3	-
Orange & Rockland	1428	1078	1214	1276	583	-	-	-	-	-
RG&E	175	318	545	465	529	1	1	2	14	1
NYPA	1061	1138	1627	792	970	-	-	-	-	-
Fuel Cost Cents per Million BTU										
Central Hudson	270	290	238	267	300	655	531	487	513	619
Con Edison	311	323	279	313	390	527	440	402	447	556
LILCO	249	290	252	279	326	408	403	382	526	457
NYSEG	-	-	-	-	-	673	530	568	680	-
Niagara Mohawk	286	323	252	287	317	447	495	484	488	-
Orange & Rockland	301	297	276	318	355	-	-	-	-	-
RG&E	323	344	286	313	337	463	430	431	600	650
NYPA	250	322	263	290	354	-	-	-	-	-

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TABLE VI-1
FUEL REQUIREMENTS - HISTORICAL - Nuclear & Conventional Hydro

	NUCLEAR					CONVENTIONAL HYDRO				
	1986	1987	1988	1989	1990	1986	1987	1988	1989	1990
Installed Gen. Cap. (MW)										
New York Power Pool	3825	3842	4774	4162	4846	4011	4011	4017	4013	4057
Central Hudson	-	-	97	97	97	45	45	45	45	42
Con Edison	849	849	849	849	919	-	-	-	-	-
LILCO	-	-	194	194	194	-	-	-	-	-
NYSEG	-	-	194	193	194	70	69	67	65	68
Niagara Mohawk	610	610	1054	443	1056	609	596	596	594	626
Orange & Rockland	-	-	-	-	-	34	14	44	46	44
RG&E	470	470	621	621	621	47	17	47	47	47
NYPA	1896	1913	1765	1765	1765	3206	3210	3218	3218	3230
Fuel Consumption Billions of BTUS(2)(6)										
New York Power Pool	239373	245363	256240	247588	255747					
Central Hudson	-	-	3550	4319	4120					
Con Edison	43993	58423	66543	49461	56576					
LILCO	-	-	7105	8662	8845					
NYSEG	-	-	7099	8638	8240					
Niagara Mohawk	33294	48542	11641	19676	32657					
Orange & Rockland	-	-	-	-	-					
RG&E	38661	40538	41661	39660	43024					
NYPA	123425	97860	118641	117172	102285					
Generation (GWH)										
New York Power Pool	22086	22584	23652	22921	23670	30317	28280	24657	24793	26588
Central Hudson	-	-	320	386	371	135	127	122	116	154
Con Edison	3794	5127	6043	4446	5189	-	-	-	-	-
LILCO	-	-	639	771	741	-	-	-	-	-
NYSEG	-	-	639	773	743	338	280	245	292	355
Niagara Mohawk	3117	4615	1059	1762	2975	3477	2724	2494	3004	3355
Orange & Rockland	-	-	-	-	-	158	193	163	145	201
RG&E	3603	3793	3884	3659	4017	235	224	169	175	245
NYPA	11542	9049	11068	11124	9634	25974	24732	21464	21061	22278
Fuel Cost Cents per Million BTU										
Central Hudson	-	-	145	95	109					
Con Edison	55	56	50	50	63					
LILCO	-	-	118	116	81					
NYSEG	-	-	106	99	99					
Niagara Mohawk	64	65	111	115	94					
Orange & Rockland	-	-	-	-	-					
RG&E	48	51	49	50	56					
NYPA	66	68	56	63	56					

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